11.0 COSTS OF TECHNOLOGY BASES FOR REGULATIONS

This section describes the methodology used to estimate the costs for implementing each of the technology options under consideration for the MP&M Point Source Category. Section 8.0 describes the technologies considered and Section 9.0 describes the combination of these technologies into options for in-process source reduction and recycling and end-of-pipe wastewater treatment. The cost estimates, together with the pollutant reduction estimates described in Section 12.0, provide a basis for evaluating the options discussed in Section 9.0. The cost estimates also provide a basis for determining the economic impact of the regulation on the industry as discussed in the report titled Economic, Environmental, & Benefit Analysis of the Proposed Metal Products & Machinery Rule (EEBA) (1). The EEBA is included in the public record for this rulemaking.

EPA used the following approach to estimate compliance costs for the MP&M industry.

- Select probability samples of MP&M industry sites to receive industry surveys (see Section 3.0). EPA estimated costs of compliance for each survey site (i.e., model site) based on factors such as unit operations, wastewater characteristics, treatment currently in place, etc. (see Section 11.2).

- Analyze field sampling data for unit operations to determine the pollutant concentrations of untreated wastewater in the industry (see Section 12.0).

- Identify candidate in-process source reduction and recycling and end-of-pipe wastewater treatment technologies, and group them into technology options. The technology options serve as the basis of compliance cost and pollutant loading calculations (see Section 9.0).

- Analyze field sampling data for wastewater treatment systems to determine pollutant removal performance of the selected technologies (see Section 10.0).

- Develop cost equations for capital and operating and maintenance (O&M) costs for each of the technologies (see Section 11.4).

- Evaluate the current (baseline) treatment technology in place at each model site (i.e., survey site) and estimate baseline pollutant loadings and operating and maintenance costs using a computerized design and cost model (the MP&M Design and Cost Model).

- Use the MP&M Design and Cost Model to estimate compliance costs (presented in Section 11.2) and pollutant loadings (presented in Section 12.0) for each model site for each option.

- Use sample weights based on survey sample frame to estimate, for national population, industry compliance costs and pollutant loadings.

- Estimate total annualized costs, cost effectiveness, and the economic impact to the industry (presented in the EEBA) using output from the MP&M Design and Cost Model.

EPA estimated industry-wide costs for 10 technology options by computing compliance costs for technology trains at 890 model sites. The Agency used these model sites to estimate costs for 63,000 water-discharging MP&M sites using statistically calculated industry weighting factors (i.e., sample weights). Many of these 63,000 MP&M sites are indirect dischargers with flows under the proposed low flow exclusions and are not included in the final cost estimates of the proposed rule. Section 11.1 summarizes the results of the costing effort. Section 11.2 presents the methodology used to select and develop model sites. Section 11.3 presents the methodology for estimating costs, including descriptions of the components that define capital and annual costs, sources of cost data, standardization of cost data, an overview of the MP&M Design and Cost Model, and general assumptions used for costing. Section 11.4 describes the design and costing methodology for each in-process and end-of-pipe technology used in the options. Tables are presented in the text and figures are located at the end of this section.

11.1 Summary of Costs

EPA identified several in-process and end-of-pipe technologies applicable to MP&M wastewater (Section 8.0), and combined these into technology options (Section 9.0). Overall, EPA considered 10 technology options, although several options are only applicable to certain MP&M subcategories. Based on the technologies included in each option and the specific wastewater generated at the MP&M model sites (based on questionnaire responses), EPA used the MP&M Design and Cost Model to estimate compliance costs for each model site for each option.

Table 11-1 presents annualized costs for both direct and indirect dischargers by subcategory for all proposed options for existing sources (Options 2, 6, 10). Costs for options that EPA did not propose are not presented in this section but are discussed in Section 14. EPA notes that costs for options 1, 3, 5, 7, and 9 (those options without pollution prevention (P2) cost more and remove fewer pollutants than the comparable technology with pollution prevention (see Section 14).

Cost estimates presented in Table 11-1 will not equate with those presented in the EEBA because those costs include other system annual costs (e.g., taxes and amortization). In

addition, EEBA cost estimates are presented in 1999 dollars (where costs in this section are in 1996 dollars), and the EEBA cost estimates do not include costs for facilities that are projected to close in the baseline based on a site's responses to EPA's economic portion of industry questionnaires, (i.e., based on a site's responses to EPA's economic portion of industry questionnaires, EPA estimates these facilities will close, regardless of the MP&M effluent guidelines, prior to the implementation of the MP&M guidelines).

Table 11-1

MP&M Total Estimated Annualized Costs at the Proposed Options for Existing Sources

Subcategory	Proposed Option Number	Direct Dischargers		Indirect Dischargers		
		Number of Sites	Total Annualized Cost (millions of 1996 dollars)	Number of Sites	Flow Cutoff	Total Annualized Cost (millions of 1996 dollars)
General Metals	2	3,794	230	3,055	1 MGY	1,570
Metal Finishing Job Shop	2	15	1.3	1,514	None	178
Non-Chromium Anodizing	2	NA	NA	Not Proposed	None	Not Proposed
Printed Wiring Board	2	11	2.5	621	None	147
Steel Forming and Finishing	2	43	29.3	110	None	24
Oily Waste	6	911	11.2	226	2 MGY	10
Railroad Line Maintenance	10	34	1.18	Not Proposed	None	Not Proposed
Shipbuilding Dry Dock	10	6	2.15	Not Proposed	None	Not Proposed
All Categories: Annualized Costs	2/6/10	4,814	280	5,530	--------	1,930

Source: MP&M Design and Cost Model.
NA - Not applicable, EPA's data collection efforts have not identified any direct discharging non-chromium anodizing facilities.
Note: Cost estimates presented in this table will not equate with those presented in the EEBA. The cost estimates in the EEBA are presented in 1999 dollars and do not include costs for facilities that are projected to close in the baseline.

11.2 Model Site Development

The Agency used a model site approach to estimate costs for the 63,000 water-discharging sites in the MP&M Point Source Category based on cost estimates for a statistically sampled subset of sites. To account for the variability in processes and treatment systems in place within the MP&M Point Source Category, EPA developed a model site from each survey (see Section 3.0) that met the criteria described below.

11.2.1 Site Selection

EPA selected model sites from sites receiving industry surveys. Section 3.1 discuss data collection and survey activities. The Agency selected a site as a model site if it met the following criteria:

- The site discharged wastewater (treated or untreated) to either a surface water or publicly owned treatment works (POTW); and

- The site supplied sufficient technical data required to estimate compliance costs and pollutant loadings reductions associated with the technology options.

Based on these criteria, EPA selected 890 survey respondents for model site development. The Agency used statistically-determined survey weights to estimate the national MP&M industry population of 63,000 sites. Development of the survey weights and the statistical methodology used to characterize the industry are documented in the public record for this rulemaking.

11.2.2 Wastewater Stream Parameters

Based on the information provided by the sites in their survey responses, follow-up letters, and phone calls, EPA classified each process wastewater stream at each site by the type of unit operation (e.g., machining, electroplating, acid treatment) generating the wastewater. For each operation, EPA used survey data to obtain the following parameters:

- **Wastewater discharge flow rate.** For each process wastewater stream, sites reported the total wastewater discharge flow rate from the unit operation. For sites that did not report wastewater discharge data, EPA statistically imputed wastewater flow rates using other data provided in the site's survey or by using data for similar unit operations reported in other surveys. The approach for this modeling is documented in the public record for this rulemaking.

- **Production rate.** Sites reported production rates in either surface area processed, mass of metal removed, or air flow rate. The production

parameter used depended on the unit operation. EPA used surface area for surface finishing or cleaning operations, mass of metal removed for metal removal operations such as machining and grinding, and air flow rate for air pollution control operations. For sites that did not report production data, EPA statistically imputed production rates using other data provided in the site's survey or by using data for similar unit operations reported in other surveys. The approach for this modeling is documented in the public record for this rulemaking.

- **Operating schedule.** EPA used survey responses to estimate the operating rate (hours per day (hpd) and days per year (dpy)) of each unit operation when supplied by sites. For blank responses, EPA used the following:
  - The maximum hpd and dpy reported by the site for other unit operations;
  - The survey response for wastewater treatment system operating schedule, if all hpd and dpy responses at the unit operation level were blank; or
  - 8 hpd and 250 dpy, if all unit operation operating rate survey responses were blank and no wastewater treatment system operating schedule was provided.
- **Discharge destination.** EPA used survey responses to determine whether each unit operation discharged process wastewater, and if so, whether the wastewater was discharged to a surface water or POTW. EPA also determined from the survey responses whether the wastewater was treated on site prior to discharge. The MP&M Design and Cost Model did not assign costs to wastewater that sites reported to be contract hauled off site, deep-well injected, discharged to septic systems, not discharged, or reused on site. For sites that did not report a discharge destination for some or all operations, EPA modeled the destination based on other technical information provided in the survey (e.g., types of discharge permits, discharge destination of other unit operations, process flow diagrams).

11.2.3 Pollutant Concentrations

The Agency estimated the concentration of each pollutant in each model site's process wastewater stream using field sampling data for raw wastewater discharged from MP&M unit operations. Section 3.0 discusses the field sampling program. EPA used these data with survey flow and production data to calculate the pollutant loadings. Section 12.0 discusses these calculations in more detail as well as the calculations for estimating site specific pollutant

removals. In addition, Section 10 provides information about the data used to estimate pollutant concentrations in the effluent stream following treatment for the various technology options.

11.2.4 Technology in Place

The term "technology in place" refers to those technologies that the Agency considered to be installed and operating at a model site at the time the facility completed the detailed industry survey. EPA accounted for technology in place in the costing and pollutant removal efforts to ensure that EPA accurately assessed the treatment costs associated with a facility upgrading its treatment system (including P2) to meet the MP&M standards and the current level of pollutant being discharged by facilities with treatment in place.

Although both the 1989 and 1996 MP&M Detailed Surveys requested detailed information on end-of-pipe treatment-in-place, only the 1996 MP&M Detailed Survey requested information about a facility's in-process pollution prevention technologies. For the 1996 MP&M Detailed Surveys, EPA assigned pollution prevention technology in place based on information contained in the responses to this survey. For other model sites, the Agency assumed in-process pollution prevention technologies were in place for a particular unit operation if the model site's process wastewater stream had a production-normalized flow rate (PNF, volume of wastewater per unit of production) below the median PNF calculated from the 1996 MP&M Detailed Survey for processes incorporating that pollution prevention technology. For example, if a 1989 survey site reported a machining wastewater stream with a PNF below the median PNF for centrifugation and pasteurization of machining coolant, then the Agency assumed that the model site had a machining coolant regeneration system in place. The median PNFs for each technology are listed in Section 15 and documented in the public record for this rulemaking.

EPA used a similar method to give credit to sites using efficient rinse schemes. EPA used the following parameters to compute flow reductions and costs for incorporating pollution prevention in rinse lines by converting the rinse to a two-stage countercurrent rinse. Additional information on the in-process pollution prevention and rinse flow reduction methodology can be found in the public record for this rulemaking.

- **Tank volume.** Although tank volume is a design parameter for countercurrent cascade rinsing, the Agency did not request this information in the surveys. EPA used a linear relationship between tank size and annual discharge flow rate to estimate the volume of the existing tank and for the estimated volumes of additional rinse tank(s) that may need to be installed in order to incorporate countercurrent cascade rinsing.

- **Rinse code.** EPA uses the rinse code parameter to compute a flow reduction for conversion of the model site's current rinse scheme to a two-stage countercurrent rinse. The 1996 MP&M Detailed Surveys contained specific information about each rinse. EPA used this information to determine the median PNF for each of the five general rinse categories.

As documented in the public record for this rulemaking, EPA assigned rinses from all surveys one of the five general rinse codes based on specific rinse code information contained in the survey or the PNF for the rinse stream. The Agency used these codes to estimate rinse flow reduction costs for model sites that do not currently use countercurrent rinsing.

- **Equipment code.** EPA determined the type of rinse equipment in place and assigned an equipment code based on the detailed rinse information in the 1996 surveys. For surveys that did not contain detailed information, EPA used the model site's PNF to assign an equipment code.

EPA reviewed survey data for each model site to assess the types of preliminary and end-of-pipe technologies in place at each site (e.g., chemical reduction of chromium, sludge pressure filtration). EPA identified end-of-pipe technologies on site that, based on technical considerations, it considered equivalent to technologies included in the technology options. For example, the Agency considered vacuum filtration to be equivalent to pressure filtration for sludge dewatering. EPA also identified technologies that it did not consider equivalent, and for which it assigned no credit for technology in place. For example, EPA did not consider oil/water separation equivalent to ultrafiltration in the technology options; however, it did consider ultrafiltration to be treatment in place for treatment options specifying oil/water separation or dissolved air flotation. EPA assumed that sites specifying only chemical precipitation also had a clarifier. In addition, the Agency assumed sites with treatment systems in place have the associated chemical feed systems in place. Site-specific assumptions regarding treatment technologies in place at model sites are included in the administrative record for this rulemaking (Technology in Place Documentation for MP&M Phase I/II Survey Respondents, DCN 16323/15799).

EPA used survey data for the following parameters to assess the capacity of the end-of-pipe technologies in place at the model sites:

- **Operating schedule.** EPA used survey responses to estimate the operating schedule (hours per day (hpd) and days per year (dpy)) for each treatment unit when supplied by sites. For blank responses, EPA determined the schedule using the following:

  - The maximum hpd and dpy reported for the unit operations, if all hpd and dpy responses for the treatment unit were blank;

  - The maximum hpd and dpy reported by the site for other unit operations associated with other treatment units; or

  - 8 hpd and 250 dpy, if all hpd and dpy survey responses were blank for unit operations and treatment units.

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- **Wastewater streams treated.** EPA determined the unit operation wastewater streams treated by each end-of-pipe technology in place using the following:

  - Survey process flow diagrams or responses to survey questions regarding the destination of individual process wastewater streams, and

  - The logic used by the model for assigning streams to technologies if information provided in the survey was insufficient, (e.g., EPA assumed that sites treated cyanide-bearing streams using cyanide destruction if the site currently had it in place). This logic is described in Section 11.3.

EPA used the baseline operating schedule and wastewater streams treated by the technology to define the maximum operating capacity for each technology. The Agency determined design capacity flow from the larger of the survey response flow (when available) or the model design capacity flow as derived from the baseline flow. EPA assumed that each model site with end-of-pipe treatment technologies in place operated their system at 78 percent of full capacity (at baseline). The Agency estimated the operating capacity based on an average of survey data (documentation is included in the public record for this rulemaking). Because a site may need to increase its wastewater treatment capacity as a result of the process changes associated with some of EPA's technology options, Section 11.3.4 presents assumptions regarding how the model accounted for baseline end-of-pipe technologies with insufficient capacity.

11.3 Methodology for Estimating Costs

This section discusses the methodology for estimating costs, including the components of cost (Section 11.3.1), the sources and standardization of cost data (Section 11.3.2), the MP&M Design and Cost Model (Section 11.3.3), and the general assumptions made during the costing effort (Section 11.3.4).

11.3.1 Components of Cost

The components of the capital and annual costs and the terminology used in developing these costs are presented below.

Capital Costs

The capital costs consist of two major components: direct capital costs and indirect capital costs. The direct capital costs include:

- Purchased equipment cost, including ancillary equipment (e.g., piping, valves, controllers);
- Delivery cost (based on the equipment weight and a shipping distance of 500 miles); and
- Installation cost (including labor and site work).

EPA derived the direct components of the total capital cost separately for each treatment unit or pollution prevention technology. When possible, EPA obtained costs for various sizes of preassembled, skid-mounted treatment units from equipment vendors. If costs for preassembled, skid-mounted treatment units were not available, EPA obtained catalog prices for individual system components (e.g., pumps, tanks, feed systems) and summed these prices to estimate the cost for the treatment unit.

Indirect capital costs consist of secondary containment, engineering, contingency, and contractor fees. When combined with the direct capital costs, these form the total capital investment. EPA estimates the indirect costs as percentages of the total direct capital cost, as shown in Table 11-2.

Table 11-2

Components of Total Capital Investment

Item Number	Item	Cost
1	Equipment capital costs including required accessories, installation, delivery, electrical and instrumentation, yard piping, enclosure, pumping, and retrofit allowance	Direct capital cost
2	Engineering/administrative and legal	10% of item 1
3	Secondary containment/land costs	10% of item 1
4	Total plant cost	Sum of items 1 through 3
5	Contingency	15% of item 4
6	Contractor’s fee	5% of item 4
7	Total capital investment	Sum of items 4 through 6

Source: MP&M Design and Cost Model.

Annual Costs

As with capital costs, the annual costs have both a direct and an indirect component. The equations used to calculate individual equipment direct annual costs include the following.

- **Raw material costs.** Chemicals and other materials used in the treatment processes (e.g., calcium hydroxide, sulfuric acid, sodium hypochlorite);
- **Operating labor and material costs.** The labor and materials directly associated with operation of the process equipment;
- **Maintenance labor and material costs.** The labor and materials required for repair and routine maintenance of the equipment; and
- **Energy costs.** Calculated based on total energy requirements (in kW-hrs).

Indirect annual costs include monitoring, taxes, insurance, and amortization. Monitoring is the periodic analysis of wastewater effluent samples to ensure that discharge limitations are being met. Section 11.3.2 discusses assumptions regarding monitoring frequency. The EEBA discusses taxes and amortization.

Total Annualized Costs

EPA calculated total annualized costs (TAC) from the capital and annual costs generated by the MP&M Design and Cost Model. The Agency assumed a 7 percent discount rate over an estimated 15-year equipment life.

11.3.2 Sources and Standardization of Cost Data

EPA obtained capital and annual cost data for the technologies that constitute EPA's technology options (see Section 9) from equipment vendors, literature, and from existing MP&M sites. The Agency used specific data from the 1989 and 1996 MP&M Detailed Surveys whenever possible; however, the required types of data were often either not collected or not supplied by the sites. The major sources of equipment cost data were equipment vendors, while the literature provided most of the annual cost information.

Capital and annual cost data were standardized to 1996 dollars (the most current year in which EPA collected survey data) based on the following:

- **Capital Equipment.** EPA adjusted capital costs obtained in 1998 dollars to 1996 dollars using RSMeans Building Construction Historical Cost Indexes (see Table 11-3). The values of this index for 1996 and 1998 were 110.2 and 114.4, respectively. EPA decreased capital equipment

costs by 3.7 percent (110.2/114.4 × 100) to account for inflationary changes between 1996 and 1998.

- **Chemicals.** EPA used the Chemical Marketing Reporter from December, 1997 to obtain chemical prices.

- **Water and Sewer Costs.** EPA based water and sewer use prices on data collected through an EPA Internet search of various public utilities located throughout the United States for years ranging from 1996 to 1999. EPA adjusted rates to a 1996 basis using the RSMeans Building Construction Historical Cost Indexes. The average water and sewer use charges were $2.03 per 1,000 gallons and $2.25 per 1,000 gallons, respectively.

- **Energy.** EPA determined electricity prices from the U.S. Department of Energy's Energy Information Administration. The average electrical cost to industrial users from 1994 to 1996 was $0.047 per kW-hr.

- **Labor.** EPA used labor rate of $29.67 per hour to convert the labor requirements of each technology into annual costs. The Agency obtained the base labor rate from the Monthly Labor Review, which is published by the U.S. Bureau of Labor Statistics of the U.S. Department of Labor. Excluding the maximum and minimum values, EPA used the largest remaining monthly value for 1997 for production labor in the fabricated metals industry, $12.90 per hour, as a conservative estimate. The Agency added 15 percent of the base labor rate for supervision and 100 percent for overhead to obtain the labor rate of $29.67 per hour.

- **Monitoring.** EPA did not include the annual cost of wastewater analyses because it assumed that no incremental monitoring costs would be incurred at the technology options above a site's current baseline monitoring.

- **Contract Hauling.** EPA based contract-hauling costs on averaged data from the 1996 MP&M Detailed and Screener Surveys as discussed in Section 11.4.4. The Agency estimated costs for contract hauling of RCRA hazardous metal hydroxide sludge from Pollution Prevention and Control Technology for Plating Operations (3). The contract hauling costs for various waste types are provided in Table 11-4.

Table 11-3

RSMeans Building Construction Historical Cost Indexes

Year	Index
1989	92.1
1990	94.3
1991	96.8
1992	99.4
1993	101.7
1994	104.4
1995	107.6
1996	110.2
1997	112.8
1998	114.4

Reference: Historical Cost Indexes, RSMeans Building Construction Cost Data, 56th Annual Edition, 1998, page 594. (2)

Table 11-4

Contract-Hauling Costs for Various Waste Types

Waste Type	Cost ($/gallon)
RCRA hazardous non-hazardous paint sludge	3.70
RCRA hazardous metal hydroxide sludge (3)	1.95
RCRA non-hazardous oil	0.86
Solvent (paint and paint stripping waste)	2.85
Oily wastewater	1.33
General metal-bearing wastewater	2.00
Cyanide-bearing wastewater	5.64
Hexavalent chromium-bearing wastewater	3.51
Chelated metal-bearing wastewater	1.40

Source: 1996 MP&M Detailed and Screener Surveys.

11.3.3 MP&M Design and Cost Model

The Agency developed cost modules for the in-process source reduction and recycling and end-of-pipe wastewater treatment technologies and practices included in the technology options. Table 11-5 presents these technologies and practices. Specific details regarding the design and costing of each technology and practice are described in Section 11.4.

Figure 11-1 shows the relationship between in-process and end-of-pipe technologies and practices.

Table 11-5

Wastewater Treatment Technologies and Source Reduction and Recycling Practices for Which EPA Developed Cost Modules

In-Process Technologies and Practices	End-Of-Pipe Technologies and Practices
Countercurrent cascade rinsing Centrifugation and pasteurization of machining coolants Centrifugation of painting water curtains	Chemical reduction of hexavalent chromium Cyanide destruction Chemical reduction of chelated metals Chemical emulsion breaking Gravity oil/water separation Dissolved air flotation Gravity oil emulsion breaking (baseline only, see Section 11.3.4) Ultrafiltration for oil removal Contract hauling of solvent degreasing wastewaters Chemical precipitation Gravity clarification for solids removal Microfiltration for solids removal Sludge thickening Sludge pressure filtration Multimedia filter (baseline only, see Section 11.3.4)

Source: MP&M surveys, MP&M site visits, technical literature.

EPA developed a computerized design and cost model to estimate compliance costs and pollutant loadings for the MP&M technology options, taking into account each site's treatment in place. The model was programmed with modules, which allowed the user to specify various combinations of technologies and pollution prevention practices to be costed as required by the technology options and as required by each model site's wastewater stream characteristics. A baseline run estimated current annual costs (operating and maintenance) for each site and assessed the current capacity of treatment equipment in place using the site's specified treatment equipment and the estimated wastewater flow requiring a particular type of treatment. For estimating costs and pollutant loadings for each of the technology options, the model costed each site by assigning a particular type of treatment unit to each wastestream generated by the site (see Table 11-6). EPA took into account current treatment in place and existing annual costs (for chemical addition, etc.) from baseline when estimating costs associated with the proposed rule. EPA designated specifically which unit operations would feed each treatment unit (or pollution prevention technology) based on the properties of that unit operation's discharge stream (e.g., cyanide bearing wastewater feeds cyanide destruction, flowing rinses feed countercurrent cascade rinsing).

In the context of the MP&M cost program, "model" refers to the overall computer program and "module" refers to a computer subroutine that generates costs and pollutant

loadings for a specific in-process or end-of-pipe technology or practice (e.g., chemical precipitation and sedimentation, contract hauling). EPA adapted some modules from cost modules used for previous EPA rulemaking efforts for the metals industry, while it developed others specifically for this rulemaking effort.

Table 11-6

List of Unit Operations Feeding Each Treatment Unit or In-Process Technology

Treatment Unit / P2 Equipment	Unit Operations Feeding Unit[a]
Countercurrent cascade rinsing	Acid treatment with chromium rinse
	Acid treatment without chromium rinse
	Alkaline cleaning for oil removal rinse
	Alkaline treatment with cyanide rinse
	Alkaline treatment without cyanide rinse
	Anodizing with chromium rinse
	Anodizing without chromium rinse
	Aqueous degreasing rinse
	Barrel finishing rinse
	Chemical conversion coating without chromium rinse
	Chemical milling rinse
	Chromate conversion coating rinse
	Corrosion preventive coating rinse
	Electrochemical machining rinse
	Electroless plating rinse
	Electrolytic cleaning rinse
	Electroplating with chromium rinse
	Electroplating with cyanide rinse
	Electroplating without chromium or cyanide rinse
	Electropolishing rinse
	Heat treating rinse
	Salt bath descaling rinse
	Solvent degreasing rinse
	Stripping (paint) rinse
	Stripping (metallic coating) rinse
	Testing rinse
	Washing finished products rinse
	Carbon black deposition rinse

Table 11-6 (Continued)

Treatment Unit / P2 Equipment	Unit Operations Feeding Unit[a]
	Galvanizing/hot dip coating rinse
	Mechanical plating rinse
	Laundering rinse
Countercurrent cascade rinsing (cont.)	Cyanide rinsing
	Ultrasonic machining rinse
	Phosphor deposition rinse
Centrifiguration and pasteurization of machining coolant	Multiple unit operation rinse
	Grinding
	Machining
Centrifugation of painting water curtains	Painting - spray or brush
	Painting - immersion
Chemical emulsion breaking and Oil/water separation OR Dissolved air flotation OR Ultrafiltration system for oil removal	Alkaline cleaning for oil removal and rinse
	Aqueous degreasing
	Assembly/disassembly
	Electrical discharge machining rinse
	Electrolytic cleaning
	Electroplating without chromium or cyanide
	Floor cleaning and rinse
	Grinding rinse
	Heat treating
	Impact deformation and rinse
	Machining and rinse
	Painting - spray or brush
	Painting - immersion
	Pressure deformation
	Stripping (paint)
	Stripping (metallic coating) rinse
	Testing
	Thermal cutting rinse
	Washing finished products and rinse
	Bilge water
	Mechanical plating
	Photo image developing
	Photo imaging
	Steam cleaning
	Vacuum impregnation

Table 11-6 (Continued)

Treatment Unit / P2 Equipment	Unit Operations Feeding Unit[a]
	Laundering
	Calibration
	Centrifugation and pasteurization of machining coolant
Chemical reduction of hexavalent chromium	Acid treatment with chromium and rinse
	Anodizing with chromium and rinse
	Chromate conversion coating and rinse
	Electroplating with chromium and rinse
	Stripping (paint)
	Wet air pollution control - chromium
	Chromium drag-out reduction and rinse
Chemical reduction of chelated metals	Electroless plating and rinse
Cyanide destruction	Alkaline treatment with cyanide and rinse
	Electroplating with cyanide and rinse
	Cyanide rinsing and rinse
	Cyanide drag-out destruction and rinse
	Wet air pollution control - cyanide
Solvent hauling	Solvent degreasing

[a] Note - A unit operation can feed more than one treatment unit or in-process pollution prevention technology. EPA assumed that the model sites commingled all MP&M wastewater generated for treatment by chemical precipitation, except for wastewater from the Oily Wastes, the Shipbuilding Dry Dock and Railroad Line Maintenance subcategories, and except for solvent-bearing wastewater which EPA costed for off-site disposal.

Figure 11-2 shows the logic used by the MP&M Design and Cost Model to apply the in-process technologies and pollution prevention practices to each site. For streams at model sites that EPA determined to not have technology in place (see Section 11.2.4), EPA applied flow reductions for each in-process technology as summarized below:

- EPA estimated a 20 to 80 percent flow reduction achieved by converting the current rinse scheme in place to countercurrent cascade rinsing.

- EPA assumed centrifugation and pasteurization of machining coolants reduced coolant use by 80 percent.

- EPA assumed centrifugation of painting water curtains achieved zero discharge of wastewater through 100 percent reuse of the treated wastewater in the painting booth (sludge removed from the centrifuge is contract hauled).

For countercurrent cascade rinsing, EPA estimated costs for each individual rinse stream at a site. EPA assumed that a site combined all wastewater from machining operations prior to centrifugation and pasteurization of machining coolants and combined wastewater from painting streams prior to paint curtain centrifugation.

Figure 11-3 presents the logic used by the MP&M Design and Cost Model to apply the end-of-pipe treatment technologies and practices for the following subcategories: General Metals, Metal Finishing Job Shops, Non-Chromium Anodizing, Printed Wiring Board, and Steel Forming and Finishing. In developing costs, EPA assumed sites would segregate wastewater streams from the unit operations and the in-process pollution prevention technologies (when applicable) according to pollutant characteristics (chromium, cyanide, chelated metals, oil, and solvent). Segregation of wastestreams provides for the most efficient and effective treatment of wastes. Solvent-bearing wastewater streams were contract hauled for off-site disposal, while the other segregated wastewater streams received preliminary treatment. EPA's Design & Cost Model combined the effluent from the preliminary treatment technologies with other wastewater streams not requiring preliminary treatment then treated the combined wastewater by chemical precipitation and sedimentation. The Cost Model sends the sludge from chemical precipitation to thickening and pressure filtration prior to contract hauling for off-site disposal. Finally, the Cost Model assumes a wastewater discharge from the chemical precipitation and sedimentation system to either a surface water or POTW according to the model site's current discharge destination (see Section 11.3.4 for general discharge status assumptions for sites with multiple discharge destinations).

Figure 11-4 presents the logic used by the MP&M Design and Cost Model to apply the end-of-pipe treatment technologies and pollution prevention practices for the Oily Wastes, Railroad Line Maintenance, and Shipbuilding Dry Dock subcategories. Each of these subcategories generates wastewater that primarily contains oily constituents; therefore, EPA did not include chemical precipitation and sedimentation following oil treatment in the Cost Model.

The model provided the following information, as applicable, for each technology designed for a model site:

- Total direct capital costs;
- Total direct annual costs;
- Electricity used and associated cost;
- Sludge generation and associated disposal costs;
- Waste oil generation and associated disposal costs;
- Water use reduction and associated cost credit;
- Chemical usage reduction and associated cost credit;
- Effluent flow rate; and
- Effluent pollutant concentrations.

Section 11.4 provides specific information calculated by each technology module.

11.3.4 General Assumptions Made During the Costing Effort

This section presents general assumptions that EPA applied throughout the MP&M Design and Cost Model. Technology-specific assumptions are presented under the appropriate technology descriptions in Section 11.4.

Calculation of Baseline Parameters

As discussed in Section 11.2.4, EPA determined the technologies in place, including the operating schedules and the wastewater streams treated as specified in the MP&M survey by the model site. Using this survey information, EPA modeled each site's current costs and pollutant loads, referred to as baseline values. EPA uses baseline values as the basis for determining the incremental costs and loads associated with each technology option. Before running the Cost Model for any of the technology options, EPA conducted a baseline run of the model to determine the following:

- Baseline (survey year) operating and maintenance costs incurred by sites in 1996 dollars;
- Baseline non-water quality impacts such as electricity usage, sludge generation, and waste oil generation;
- Baseline pollutant loadings; and
- Capacity flow rate of each wastewater treatment technology in place.

Because the purpose of the baseline run was to simulate the current treatment practices at each site, this run included technologies (e.g., batch emulsion breaking and gravity flotation, multimedia filtration) that EPA did not include in the technology options. The baseline run also reflected treatment combinations currently used by model sites that the Agency did not use in the technology options (e.g., gravity oil/water separation followed by ultrafiltration, batch emulsion breaking and gravity flotation followed by dissolved air flotation). As a conservative estimate for estimating baseline pollutant loadings (loadings prior to compliance with these proposed regulations), EPA assumed that all sites with treatment currently in place (including those sites not currently covered by the Metal Finishing regulations) were currently meeting the long-term average (LTA) concentrations (i.e., design concentrations) for the pollutants limited under the Metal Finishing effluent guidelines (40 CFR Part 433) and were meeting the LTA concentrations achieved by EPA's sampled BAT facilities for other pollutants of concern (i.e., those pollutants not regulated under 40 CFR Part 433). For sites that did not report treatment in place, EPA estimated baseline pollutant loadings on EPA's unit operation-by-unit operation sampling data for raw wastewater.

EPA subtracted the baseline values for operating and maintenance costs, non-water quality impacts, and pollutant loadings from the corresponding values calculated from each

technology option to determine the incremental impact in relation to the baseline for each technology option.

End-of-Pipe Technology in Place

EPA designed the Cost Model to account for in-process and end-of-pipe operating equipment already in place at the model sites. For end-of-pipe treatment technologies, EPA reviewed information in the surveys to assess which of the treatment technologies included in each option were in place at the sites. Some sites had no technologies in place, some had incomplete treatment in place, and others had complete treatment in place. EPA also assessed the design capacity flow for each treatment unit in place to determine whether each site had sufficient capacity to treat all of its MP&M process wastewater. The Agency derived design capacity flow from the larger of the site's reported survey value or the site's Cost Model design capacity flow (as derived from the baseline flow), assuming baseline flow was 78 percent of capacity (EPA based this assumption on the average value reported in surveys). For some treatment options, EPA's Cost Model selected treatment for a wastewater stream (see Table 11-6) that differed from the treatment utilized by the site at baseline. This situation sometimes required a treatment unit at a model site to treat additional wastewater streams at the EPA option. In these situations, the treatment capacity of the technology in place at baseline may have been insufficient. EPA made the following assumptions regarding capital costs and end-of-pipe technology capacities:

- If the technology was not in place at the model site, then EPA assigned capital costs to the site for a treatment unit of sufficient capacity;
- If the technology was in place at the model site with sufficient capacity to treat all of the wastewater, then EPA assigned no capital costs; and
- If the technology was in place at the model site but with insufficient capacity to treat all of the wastewater, then EPA assumed the site would operate the existing system at full capacity and EPA assigned capital costs to the site for an additional treatment unit to operate in parallel with the existing unit to treat the additional flow.

Additionally, EPA assumed that some sedimentation and oil treatment systems qualified as treatment in place for multiple options. For example, a microfiltration system for solids removal would be considered treatment in place for either microfiltration or clarification depending on the technology option, while a clarifier would only be considered treatment in place for clarification. Table 11-7 lists the technologies that EPA considered treatment in place for various options for both sedimentation and oil treatment.

Table 11-7

Sedimentation and Oil Treatment Technologies Considered Treatment in Place for Various Technology Options

Technology Specified by Option	Technologies Considered Treatment in Place
Microfiltration for solids removal	Microfiltration
Clarification	Clarification or microfiltration
Ultrafiltration for oil removal	Ultrafiltration
Dissolved air flotation	Dissolved air flotation or ultrafiltration
Chemical emulsion breaking and gravity oil/water separation.	Chemical emulsion breaking and gravity oil/water separation, batch chemical emulsion breaking and gravity flotation, dissolved air flotation, or ultrafiltration

Contract Hauling in Lieu of Treatment

EPA assessed the cost of contract hauling wastewater for off-site treatment compared to on-site treatment. Because many MP&M sites have flow rates lower than the minimum design capacity of the treatment unit, EPA determined that it is often less expensive for a model site to contract haul wastewater for off-site disposal rather than to treat it on site. To assess contract hauling in lieu of treatment, EPA compared the costs of contract hauling the wastewater with the costs of the treatment unit that would be used to treat it on site. If contract hauling was less expensive than treating on site, EPA's Cost Model assigned the site costs associated with contract hauling the wastewater. EPA based this determination on individual technologies and their influent flow rates rather than on the total site wastewater treatment system. For example, for a particular site, it may be less expensive to contract haul cyanide-bearing wastewater in lieu of treatment while still treating all other wastewater streams on site. The calculation for determining whether treatment on site was less expensive assumed an equipment life expectancy of 15 years and an annual interest rate of 7 percent.

EPA compared the following technologies to contract hauling in lieu of treatment:

- Centrifugation and pasteurization of machining coolants;
- Centrifugation of painting water curtains (general metal-bearing waste and paint sludge);
- Chemical reduction of hexavalent chromium;
- Cyanide destruction;
- Chemical reduction of chelated metals;
- Chemical emulsion breaking and gravity oil/water separation;
- Dissolved air flotation;

- Ultrafiltration for oil removal;
- Chemical precipitation and sedimentation; and
- Sludge pressure filtration.

In the case of wastewater requiring chemical precipitation and sedimentation treatment, EPA compared the costs of contract hauling the untreated end-of-pipe wastewater to the cost of the entire treatment system, which includes chemical precipitation, sedimentation (gravity clarification or microfiltration), sludge thickening, and pressure filtration.

Equipment Size Ranges

EPA developed equipment cost equations for each component of the treatment technologies. The validity ranges represent the minimum and maximum sizes (e.g., flow rates, volume capacities) for which EPA developed the equations. For wastewater streams requiring equipment with a capacity below the minimum range of validity, the cost model designed the equipment at the minimum size. For wastewater streams requiring equipment with a capacity above the maximum range of validity, the cost model designed multiple units of equal capacity to operate in parallel such that the equipment sizes were within the range of validity.

Batch Schedules

EPA designed either batch or continuous systems, depending on each model site's operating schedule and discharge flow rate. For batch systems, EPA determined the batch volume and operating schedule to minimize costs. If the volume of wastewater to be treated in a single day was less than the capacity of the minimum batch system size based on vendor information, then the Agency altered the site's wastewater treatment operating schedule such that the minimum system would be operated at capacity. For example, if the minimum cyanide destruction system was 480 gallons per batch, and a site generated 80 gallons of cyanide-bearing wastewater per day, then the Cost Model designed the cyanide destruction system to treat a 480-gallon batch once every six days.

Dilute Influent Concentrations

In rare cases, high wastewater flow rates at some sites resulted in pollutant concentrations below the long-term average technology effectiveness concentrations (discussed in Section 10.0) even after EPA applied its in-process pollution prevention practices to reduce the site's flow. In these cases, the Cost Model did not design or provide costs for a technology at the EPA option for that wastewater stream. When this situation occurred during the baseline run of the model, the Cost Model assigned costs for technologies in place.

Discharge Status

EPA classified a stream's discharge status as direct, indirect, contract haul, reuse, or zero discharge. Some model sites discharge their wastewater streams to multiple discharge

destinations at baseline. Although the Cost Model allows segregated streams to be contract hauled for off-site disposal, it assumes the model site combines the wastewater sent to treatment prior to chemical precipitation and sedimentation. Therefore, EPA assigned a single discharge status to each model site based on the following assumptions:

- EPA considered a site with any combination of individual MP&M streams with a direct discharging stream a direct discharging site;
- EPA considered a site with any combination of individual MP&M streams, except direct, with an indirect discharging stream an indirect discharging site; and
- EPA considered a site with any combination of individual MP&M streams, except direct and indirect, a zero discharger/contract-hauled site.

11.4 Design and Costs of Individual Technologies

This section discusses in detail the design and costing of the individual technologies that comprise the technology options. Additional documentation is included in the public record for this rulemaking. Table 11-8 presents capital and annual cost equations for the specific equipment mentioned in each technology description below.

11.4.1 Countercurrent Cascade Rinsing

The Agency applied costs for countercurrent cascade rinses for flowing rinses at the model sites (see Table 11-6). EPA gave treatment in place credit to facilities with countercurrent cascade rinsing in place at baseline. The countercurrent cascade rinse module applies a flow reduction to rinses and a cost associated with the conversion to a two-stage countercurrent rinse. The Agency assigned flow reductions ranging from approximately 20 percent to 80 percent based on the site's current PNF and type of rinsing equipment. EPA used information from the 1996 MP&M Detailed Survey responses to determine the percentages of flow reductions, as documented in the public record for this rulemaking. (See Section 15.2.4 for more information on countercurrent cascade rinsing flow reduction as related to the site's existing rinse scheme).

EPA applied costs based on the site's current rinse scheme. The module included capital and annual costs for the following equipment when necessary.

- A second rinse tank with a volume equal to the volume of the existing tank;
- Transfer pumps and piping; and
- An air-agitation system.

EPA did not include additional operating and maintenance costs for countercurrent cascade rinses because these would be the same as for the original rinse. Direct annual costs for this module included energy costs and a credit for water-use reduction. EPA

based the cost credit for water-use savings on the annual flow reduction for each countercurrent cascade rinse system and an average source water charge (as determined in Section 11.3.2).

Table 11-8

MP&M Equipment Cost Equations[a]

Equipment	Equation	Range of Validity
Countercurrent cascade rinsing	**A** = [(0.0004*TANKVOL + 0.2243)]*DPY*HPD*0.047] - [(Y-CCFLOW)*60*HPD*DPY*0.00203]	
	C = 6.047*TANKVOL + 3784.3	Tank, piping, and pump
	C = 0.5077*TANKVOL + 1077.8	Piping and pump
	C = 8*29.67	Labor only
Machine coolant regeneration system (including holding tanks)	**A** = [18*0.047*DPY*HPD] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67] + [0.002*Y*60*HPD*DPY*1.95]+ [0.05*Y*60*HPD*DPY*0.86] - [0.05*0.80*Y*60*HPD*DPY*9.03] - [0.95*0.8*Y*60*HPD*DPY*0.00203]	Y#14
	C = 41,422	Y # 1
	C = 110,205	1 < Y # 2
	C = 142,831	2 < Y # 6
	C = 164,009	6 < Y # 10
	C = 191,331	10 < Y # 14
Paint curtain centrifuge	**A** = [0.047*KW*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67)] + [TSS*3.785/10^6*2.2/0.4*Y*60*HPD*DPY/8.5*3.7] - [(Y*60*HPD*DPY) - (TSS*3.785/10^6*2.2/0.4*Y*60*HPD*DPY*0.6/8.34)]*0.00203	Y#53
	C = 7,254 (kW = 0.4)	Y # 8
	C = 10,325 (kW = 1.5)	8 < Y # 13
	C = 47,104 (kW = 2.2)	13 < Y # 26
	C = 62,936 (kW=3.7)	26 < Y # 53

Table 11-8 (Continued)

Equipment	Equation	Range of Validity
Feed system, aluminum sulfate (alum)	**A** = [1.36*HPD*DPY*0.047] + [0.0006615*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	Y < 350
	A = [1.49*HPD*DPY*0.047] + [0.0006615*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	Y $ 350
	C = 9.7882*Y + 9,718.7	
Feed system, calcium chloride, continuous	**A** = [[(0.0061*Y)+1.1696]*HPD*DPY*0.047] + [0.00125*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	Y # 350
	C = 28.805*Y + 10,683	
Feed system, calcium hydroxide (lime), continuous	**A** = [[(0.0006*Y)+1.2961]*HPD*DPY*0.047] + [0.000117*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	Y # 350
	C = 24.586*Y + 12,830	
Feed system, ferric sulfate, continuous	**A** = [[(0.0009*Y)+1.3313]*HPD*DPY*0.047] + [0.0000434*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	Y # 350
	C = 11.56*Y + 9,762.9	
Feed system, polymer	**A** = [0.2833*HPD*DPY*0.047] + [0.001*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	Y < 10
	C = 3,686	
	A = [[(0.0034*Y)+1.4171]*HPD*DPY*0.047] + [0.001*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	10 # Y # 4,000
	C = 20.685*Y + 9,822	
Feed system, sodium hydroxide, continuous (caustic)	**A** = [0.1864*HPD*DPY*0.047] + [0.0042*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	Y < 10
	C = 5,120	
	A = [((0.0071*Y)+1.1584)*HPD*DPY*0.047] + [0.0042*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	10 # Y # 4,000
	C = 77.564*Y + 21,506	

Table 11-8 (Continued)

Equipment	Equation	Range of Validity
Feed system, sulfuric acid	**A** = [0.0373*HPD*DPY*0.047] + [0.000222*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	Y < 10
	C = 4,938	
	A = [[(0.0023*Y)+1.683]*HPD*DPY*0.047] + [0.000222*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	10 # Y # 4,000
	C = 56.416*Y + 17,769	
Chemical emulsion breaking, coalescent plate separator (gravity oil/water separator) [requires sulfuric acid, alum, and polymer feed systems]	**A** = [(0.0512*Y+0.4524)*HPD*DPY*0.047] + [29.67*(HPD/8)*DPY] + [(DPY/5)*29.67] + [3.664*Y*HPD*DPY]	Y # 860
	C = 328.83*Y + 28,104	
Dissolved air flotation [requires lime, ferric sulfate, and polymer feed systems]	See ultrafiltration for oil removal.	Y < 4.42
	A = [(0.0728*Y+3.072)*HPD*DPY*0.047] + [0.0045*Y*60*HPD*DPY] + [29.67*HPD*DPY] + [(DPY/5)*29.67] + [0.86*0.0003*Y*60*HPD*DPY] + [0.86*0.071*Y*60*HPD*DPY]	4.42 # Y # 350
	C = 1,125.4*Y + 137,936	
Ultrafiltration for oil removal	**A** = [(0.71*Y+5.46)*HPD*DPY*0.047] + [0.4*Y+0.3] + [0.5*HPD*DPY*29.67] + [(DPY/5)*29.67] + [65.78*Y+193.46] + [(27,123*Y/24*365*60)*0.86*60*HPD*DPY]	Y # 406
	C = 3,596*Y + 235,146	
Batch oil-emulsion breaking with gravity flotation [requires sulfuric acid, alum, and polymer feed systems]	See dissolved air flotation.	Y < 100
	A = [(0.65*Y+49.7)*HPD*DPY*0.047] + [HPD*DPY*29.67] + [(DPY/5)*29.67] + [0.022*Y*60*HPD*DPY*0.86]	100 # Y # 300
	C = 17,204*Y + 2,000,000	
Chromium reduction system, sodium metabisulfite	**A** = [2.4225*HPD*DPY*0.047] + [0.002608*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	Y # 410
	C = 261.7*Y + 24,249	

Table 11-8 (Continued)

Equipment	Equation	Range of Validity
Alkaline chlorination with hypochlorite feed system (for cyanide destruction)	**A** = [4.845*HPD*DPY*0.047] + [0.012418*Y*HPD*DPY*60] + [0.125*HPD*DPY*29.67] + [(DPY/5)*29.67]	1 # Y # 200
	C = $30,137*Y^{0.1866}$	
Chelation breaking with dithiocarbamate treatment	**A** = [2.4225*HPD*DPY*0.047] + [0.000583*Y*60*HPD*DPY] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	Y # 45
	C = 261.7*Y + 24,249	
Chemical precipitation [requires sulfuric acid, caustic, and polymer feed systems]	**A** = [0.932*HPD*DPY*0.047] + [(DPY/5)*29.67] + [(HPD/8)*DPY*29.67]	Y < 5
	C = 626.6*Y + 8,550	
	A = [((0.0571*Y)+0.0123)*HPD*DPY*0.047] + [(DPY/5)*29.67] + [(HPD/8)*DPY*29.67]	5 # Y # 4,000
	C = 784.547*Y + 34,216	
Clarifier, slant-plate (lamella)	**A** = 2*(DPY/5)*29.67	Y < 2
	C = 9,740	2 # Y < 10
	C = 15,057	10 # Y # 4,000
	C = 74.896*Y + 31,401	
Filtration, multimedia	**A** = [[(0.0504*Y)+1.0139]*HPD*DPY*0.047] + [(HPD/8)*DPY*29.67] + [(DPY/5)*29.67]	Y # 4,000
	C = 240.85*Y + 27,269	
Microfiltration system for metals removal	**A** = [(0.3*Y+6.3)*HPD*DPY*0.047] + [3.4*Y] + [0.5*HPD*DPY*29.67] + [(DPY/5)*29.67] + [184.2*Y+155.2]	Y # 406
	C = 1,728.3*Y + 69,337	
Sludge thickening	**A** = [0.246*HPD*DPY*0.047] + [2*(DPY/5)*29.67]	Y < 42
	C = 74.306*Y*60 + 3,746	
	A = [3.7*HPD*DPY*0.047] + [2*(DPY/5)*29.67]	42 # Y # 350
	C = 35.265*Y + 66,106	

Table 11-8 (Continued)

Equipment	Equation	Range of Validity
Filter press, plate-and-frame	**A** = [(60 + (30 * DPY * 2)) * NUM] + [FT3*DPY*7.48*1.95]	CFT3 # 6
	A = [(60 + (60 * DPY * 2)) * NUM] + [FT3*DPY*7.48*1.95]	CFT3 # 12
	A = [(60 + (90 * DPY * 2)) * NUM] + [FT3*DPY*7.48*1.95]	CFT3 > 12
	C = [1,658.8 * FT3] + 17,505	0.85 < FT3 # 76.5

Variable Definitions:

C = Direct capital costs (1996 dollars).
A = Direct annual costs (1996 dollars).
Y = Influent equipment flow (gallons per minute).
HPD = Operation hours per day.
DPY = Days of operation per year.
FT3 = Daily cake volume (FT^3) from all presses.
TANKVOL = Volume of countercurrent rinsing tank (gallons).
CCFLOW = Flow rate after countercurrent rinsing is supplied (gallons per minute).
kW = Kilowatts.
CFT3 = Cake volume (FT^3) per cycle per press (assume two cycles per day).
NUM = Number of filter presses.
TSS = Influent TSS concentration (mg/L).

[a]All costs are calculated in 1996 dollars.

11.4.2 Centrifugation and Pasteurization of Machining Coolant

EPA applied costs for centrifugation and pasteurization of machining coolant for machining and grinding operations discharging water-soluble or emulsified coolant (listed in Table 11-6). The treatment system used to estimate compliance costs consisted of a liquid-liquid separation centrifuge for removal of solids and tramp oils and a pasteurization unit to reduce microbial growth. The module added 50 percent excess capacity to each site's system to account for fluctuations in production. The Agency based capital and annual costs on packaged systems of different capacities. Flow rates of greater than 14 gallons per minute required multiple systems. The various size systems included the following equipment:

- High-speed, liquid-liquid separation centrifuge;
- Pasteurization unit; and
- Holding tanks for large volume applications.

Direct annual costs included operating and maintenance labor and materials, energy costs, sludge and waste oil disposal costs, and a cost credit for water- and coolant-use reduction. EPA estimated maintenance labor at one hour per week and operating labor at one hour per shift.

Based on site visit and vendor information, EPA assumed that this technology can reduce coolant discharge by 80 percent. The Agency based the amount of coolant and water saved on the site recycling 80 percent of the coolant and discharging a 20 percent blowdown stream to oil treatment. EPA assumed the coolant solution to be 95 percent water and 5 percent coolant, based on site visit and vendor information.

11.4.3 Centrifugation of Painting Water Curtains

EPA applied costs for centrifugation of painting water curtains to painting water curtain operations (listed in Table 11-6). The capital and annual costs include a centrifuge and a holding tank large enough to hold flow for one hour.

Direct annual costs included operating and maintenance labor and materials, energy costs, sludge disposal costs, and a cost credit for water-use reduction. EPA estimated maintenance labor at one hour per week and operating labor at one hour per shift.

EPA assumed that the model site reused all water discharged from the centrifugation system in painting operations, and the site contract hauled the sludge from the system as a hazardous/nonhazardous sludge. EPA estimated contract hauling costs using the average paint sludge hauling costs reported in the 1996 MP&M Detailed Surveys. Because actual disposal costs will depend on site-specific conditions (e.g., paint type and spray-gun cleaner requirements), EPA believes that the average cost for all paint sludge disposal reported in the surveys, regardless of RCRA hazard classification, is a better estimate than using either the

costs for RCRA hazardous or RCRA nonhazardous paint sludges. (See Table 11-4 for contract hauling costs and Section 11.4.4 below for more detailed information.)

11.4.4 Contract Hauling

The Agency estimated costs for off-site treatment and disposal of various types of wastes generated on site. These waste types include:

- Painting and paint stripping/solvent wastewater;
- Paint sludge;
- Wastewater containing oil and grease and organic pollutants;
- Waste oils/sludges;
- Chromium-bearing wastewater;
- Cyanide-bearing wastewater;
- Chelated metal-bearing wastewater;
- General metal-bearing wastewater; and
- Metal-bearing sludge.

Except for F006 hazardous waste, EPA estimated costs for off-site treatment and disposal of each waste type in dollars per gallon of waste using averages of cost data provided in the 1996 MP&M Detailed Surveys for contract hauling specific waste streams. The following briefly summarizes how EPA applied these costs throughout the MP&M Design and Cost Model (additional details are provided in the public record for this rulemaking);

- EPA estimated a cost of $2.85 per gallon for contract hauling painting and paint stripping wastewater for off-site treatment and disposal based on the cost for contract hauling solvent-bearing wastewater as reported in the 1996 MP&M Detailed Surveys.

- EPA estimated a cost of $3.70 per gallon for contract hauling paint sludge generated by the painting water curtain centrifugation system for landfilling as a hazardous/nonhazardous waste based on the values reported in the 1996 MP&M Detailed Surveys.

- EPA estimated a cost of $1.33 per gallon for contract hauling wastewater bearing oil and grease or other organic pollutants for off-site treatment based on the values reported in the 1996 MP&M Detailed Surveys. EPA used this estimate for sites at which the Cost Model determined contract hauling to be less expensive than treatment on site (machining coolant centrifugation and pasteurization system, chemical emulsion breaking and gravity oil/water separation, dissolved air flotation, or ultrafiltration for oil removal).

- EPA estimated a cost of $0.86 per gallon for contract hauling waste oil generated by machining coolant centrifugation and pasteurization, chemical emulsion breaking and gravity oil/water separation, dissolved air flotation, and ultrafiltration for oil removal based on the values reported in the 1996 MP&M Detailed Surveys. Dissolved air flotation also generated a waste sludge hauling cost, which was approximated using the waste oil cost.

- EPA estimated a cost of $3.51 per gallon for contract hauling hexavalent chromium-bearing wastewater for off-site treatment based on the values reported in the 1996 MP&M Detailed Surveys. EPA used this estimate for sites at which the Cost Model determined contract hauling to be less expensive than the chemical reduction of hexavalent chromium system.

- EPA estimated a cost of $5.64 per gallon for contract hauling cyanide-bearing wastewater for off-site treatment based on the values reported in the 1996 MP&M Detailed Surveys. EPA used this estimate for sites at which the Cost Model determined contract hauling to be less expensive than the cyanide destruction system.

- EPA estimated a cost of $1.40 per gallon for contract hauling chelated metal-bearing wastewater for off-site treatment based on the values reported in the 1996 MP&M Detailed Surveys. EPA used this estimate for sites at which the Cost Model determined contract hauling to be less expensive than the chemical reduction of chelated metals system.

- EPA estimated a cost of $2.00 per gallon for contract hauling metal-bearing wastewater for off-site treatment based on the values reported in the 1996 MP&M Detailed Surveys. EPA used this estimate for sites at which the Cost Model determined contract hauling to be less expensive than the chemical precipitation and sedimentation system and the sludge pressure filtration system.

- EPA estimated a cost of $1.95 per gallon for contract hauling metal-bearing sludge, generated by the sludge pressure filtration system and the machining coolant centrifugation and pasteurization system, for landfilling as an F006 hazardous waste based on the value reported in Pollution Prevention and Control Technology for Plating Operations (3).

11.4.5 Feed Systems

EPA estimated costs for generic feed systems. Where data were available, EPA incorporated treatment-specific feed systems and dosages into the treatment system costs. If this information was unavailable, EPA used literature information or engineering judgement to select

the dosages. The Agency used the following generic chemical dosages to estimate annual operating and maintenance costs:

- Polymer feed system - 20 mg/L (3);
- Continuous sodium hydroxide feed system - 1,685 mg/L (3);
- Continuous hydrated lime feed system - 376 mg/L (3);
- Continuous sulfuric acid feed system - 699 mg/L (3);
- Continuous ferric sulfate feed system - 74 mg/L (4);
- Continuous aluminum sulfate (alum) feed system - 648mg/L (4); and
- Continuous calcium chloride feed system - 830 mg/L (3).

The discussions for treatment systems that use these generic feed system costs and/or dosages refer back to this section. Capital and annual costs from these feed systems were not reported individually in Cost Model outputs but were summed into the overall treatment system capital and annual costs. The capital and annual costs for the following equipment were included:

- Raw material storage tank;
- Day storage tank with mixer;
- Chemical metering pumps;
- pH controller; and
- Supporting piping and valves.

EPA developed low-flow polymer, sodium hydroxide, and sulfuric acid feed modules with lower fixed capital and energy costs for flow rates less than 600 gallons per hour. The alum feed system was given lower energy costs for systems below 350 gallons per hour. Direct annual costs included operating and maintenance labor, energy costs, and chemicals. The polymer module also included an annual maintenance material cost that was 10 percent of the capital cost.

11.4.6 Chemical Emulsion Breaking and Gravity Oil/Water Separation

EPA estimated costs for chemical emulsion breaking and gravity oil/water separation systems to separate and remove oil and grease and organic pollutants. The Agency assumed that Model sites commingled all oil-bearing wastewater streams prior to treatment. Table 11-6 lists these wastewater streams.

For chemical emulsion breaking systems, the module included capital and annual costs for the following equipment:

- Flow equalization tank;
- Two emulsion breaking tanks;
- Two mixers;
- Sulfuric acid feed system (see Section 11.4.5);

- Polymer feed system (see Section 11.4.5);
- Alum feed system (see Section 11.4.5); and
- Wastewater pumps.

Emulsion breaking was followed by oil removal using a coalescent plate separator. For oil removal systems, the module included capital and annual costs for the following equipment:

- Feed pumps; and
- Oil/water separator.

Direct annual costs included operating and maintenance labor and materials, energy costs, raw materials (e.g,. sulfuric acid, alum, polymer), and waste oil disposal costs. Waste oil was contract hauled for off-site reclamation. EPA adjusted effluent flow rates for removal of waste oil, which it estimated to be 7.1 percent of the influent flow, based on MP&M survey data. Depending on the subcategory, EPA assumed model sites discharged the effluent from this system either to surface water or a POTW or to the chemical precipitation and sedimentation system. The Cost Model estimated costs associated with achieving the long-term average effluent concentrations of oil and grease and other pollutants removed by chemical emulsion breaking and gravity oil/water separation (see Section 10.3).

11.4.7 Dissolved Air Flotation

For the shipbuilding and railroad line maintenance subcategories, EPA estimated costs for dissolved air flotation systems to separate and remove oil and grease, suspended solids, and organic pollutants. The Agency assumed that model sites commingled all oil-bearing wastewater streams prior to treatment. Table 11-6 lists these wastewater streams.

The module included capital and annual costs for the following equipment:

- Flow equalization tank;
- Feed pumps;
- Oil/water separator;
- Chemical treatment tank;
- Lime feed system (see Section 11.4.5);
- Ferric sulfate feed system (see Section 11.4.5);
- Polymer feed system (see Section 11.4.5);
- Dissolved air flotation system with pressure tank and programmable logic controller (PLC);
- Oil storage tank; and
- Final pH adjustment tank.

Direct annual costs included operating and maintenance labor and materials, energy costs, raw materials (e.g., hydrated lime, ferric sulfate, polymer), and waste oil and sludge

disposal costs. EPA costed waste oil and sludge for contract hauling for off-site reclamation. Hydrated lime and ferric sulfate were added to the treatment flow, while the polymer volume was considered negligible. EPA adjusted effluent flow rates for removal of waste oil and sludge, which were respectively estimated as 7.1 percent and 0.03 percent of the influent flow, based on the MP&M survey data. EPA assumed model sites discharged effluent from this system either to surface water or a POTW. The Cost Model estimated costs associated with achieving long-term average effluent concentrations of oil and grease, total suspended solids, and other pollutants treated by dissolved air flotation (see Section 10.3). Because dissolved air flotation systems are not typically used for flow rates less than 265 gallons per hour, EPA costed model sites with flows less than 265 gph for ultrafiltration for oil removal.

11.4.8 Ultrafiltration System for Oil Removal

EPA estimated costs for ultrafiltration systems to separate and remove oil and grease, suspended solids, and organic pollutants. The Agency assumed that model sites commingled all oil-bearing wastewater streams prior to treatment. Table 11-6 lists these wastewater streams.

The module included capital and annual costs for the following equipment:

- Spiral-wound membrane filtration modules;
- Process and chemical tanks;
- Steel skid;
- Recirculation tank;
- Recirculation pump;
- Bag filter;
- Fix-mounted cleaning system;
- Sludge pump; and
- Electrical components (pH control/monitoring, temperature control, flow meter, pressure gauges).

Flow rates greater than 406 gallons per minute required multiple systems.

Direct annual costs included operating and maintenance labor and materials, energy costs, cleaning chemicals, membrane replacement, and waste oil disposal costs. The Cost Model assumed model sites contract hauled waste oil for off-site reclamation. Depending on the subcategory, EPA assumed the model sites discharged the effluent from this system either to surface water or a POTW or to the chemical precipitation and sedimentation system. EPA adjusted effluent flow rates for removal of waste oil, which was estimated as 5.2 percent of the influent flow, based on MP&M survey data. The Cost Model estimated costs associated with achieving long-term average effluent concentrations of oil and grease, total suspended solids, and other pollutants treated by ultrafiltration (see Section 10.3).

11.4.9 Batch Oil Emulsion Breaking with Gravity Flotation

EPA estimated costs for batch oil emulsion breaking with gravity flotation systems to separate and remove oil and grease, suspended solids, and organic pollutants. The Agency assumed that model sites commingled all oil-bearing wastewater streams prior to treatment.

Although this technology is not part of the MP&M technology options, EPA gave treatment in place credit for chemical emulsion breaking and gravity oil/water separation to sites with batch emulsion breaking with gravity flotation in place at baseline. The module included capital and annual costs for the following equipment:

- Polymer feed system (see Section 11.4.5);
- Sulfuric acid feed system (see Section 11.4.5);
- Alum feed system (see Section 11.4.5);
- Two mechanically cleaning bar screens;
- Three batch wastewater treatment tanks;
- Two segregated waste tanks;
- Three skim and saleable oil storage tanks;
- Two oil cooking tanks;
- Pumps;
- One air compressor;
- Six mixers (segregation, saleable oil, and oil cooker tanks); and
- Ancillary equipment (pipes and valves, heat trace, controls, and PLC).

Direct annual costs included operating and maintenance labor, energy costs, raw materials (e.g., polymer, sulfuric acid, alum), and waste oil disposal costs. EPA assumed model sites contract hauled waste oil for off-site reclamation. Sulfuric acid and alum were added to the treatment flow, while the polymer volume was considered negligible. The effluent from this system was discharged to the chemical precipitation and sedimentation system. EPA adjusted effluent flow rates for removal of waste oil, which was estimated as 2.2 percent of the influent flow, based on MP&M survey data. The Cost Model estimated costs associated with achieving long-term average effluent concentrations of oil and grease, total suspended solids, and other pollutants removed by this technology. For baseline, EPA used this technology for flow rates greater than 6,000 gallons per hour, whereas EPA used dissolved air flotation for flow rates between 265 and 6,000 gallons per hour and ultrafiltration for oil removal for flow rates less than 265 gallons per hour.

11.4.10 Chemical Reduction of Hexavalent Chromium

EPA estimated costs for batch and continuous systems to reduce hexavalent chromium to trivalent chromium prior to chemical precipitation and sedimentation. The Agency assumed that model sites commingled all chromium-bearing wastewater streams prior to

treatment and that all chromium in the wastewater was in the hexavalent form. Table 11-6 lists the chromium-bearing wastewater streams.

The Agency estimated costs for batch treatment for flow rates less than or equal to 600 gallons per day, and continuous systems for flow rates greater than 600 gallons per day. The module included capital and annual costs for the following equipment:

- Fiberglass reaction tank;
- Mixer;
- Sulfuric acid feed system;
- Sodium metabisulfate feed system;
- Flow equalization tank;
- Effluent pump; and
- pH and Oxidation-Reduction Potential (ORP) meters.

Direct annual costs included operating and maintenance labor and materials, energy costs, and raw materials (e.g., sulfuric acid, sodium metabisulfite). EPA based flow dependent costs on the volume of wastewater from chromium-bearing unit operations through the system, before treatment chemicals were added to the flow. EPA assumed model sites discharged effluent from this system to the chemical precipitation and sedimentation system. Although hexavalent chromium does not have a long-term average effluent concentration from chromium reduction systems (see Section 10.3), the Cost Model estimated costs associated with reducing hexavalent chromium. EPA also assumed that all other pollutant concentrations (including total chromium) remained unchanged in this treatment unit.

11.4.11 Cyanide Destruction

EPA estimated costs for batch and continuous alkaline chlorination systems to destroy cyanide prior to chemical precipitation and sedimentation. The Agency assumed that model sites commingled all cyanide-bearing wastewater streams prior to treatment. Table 11-6 lists these wastestreams. EPA assumed that model sites did not send wastestreams that did not contain cyanide to the cyanide destruction system.

The Agency estimated costs for batch treatment for flow rates less than or equal to 600 gallons per day, and continuous systems for flow rates greater than 600 gallons per day. The cost model included capital and annual costs for the following equipment:

- Two reaction tanks (batch treatment uses a single tank, with the second tank operating as a batch-holding tank);
- Mixers;
- Sodium hydroxide feed system;
- Sulfuric acid feed system;
- Sodium hypochlorite feed system;
- Effluent pumps; and

- pH and ORP meters.

Direct annual costs included operating and maintenance labor and materials, energy costs, and raw materials (e.g., sodium hydroxide, sulfuric acid, sodium hypochlorite). EPA based flow dependent costs on the volume of wastewater from cyanide-bearing unit operation through the system, before treatment chemicals were added to the flow. The Agency assumed model sites discharged effluent from this system to the chemical precipitation and sedimentation system. The Cost Model estimated costs associated with achieving the long-term effluent concentrations of total and amenable cyanide from cyanide destruction systems. EPA also assumed that all other pollutant concentrations remained unchanged in this treatment unit.

11.4.12 Chemical Reduction/Precipitation of Chelated Metals

EPA estimated costs for batch and continuous chemical reduction/precipitation of chelated metal systems to break and precipitate electroless plating complexes (e.g., copper or nickel complexes) prior to chemical precipitation and sedimentation. The Agency assumed that model sites commingled all chelated-metal-bearing wastewater streams prior to treatment. Table 11-6 lists the chelated-metal-bearing wastewater streams.

The Agency costed batch treatment for flow rates less than or equal to 600 gallons per day, and continuous systems for flow rates greater than 600 gallons per day. The cost model included capital and annual costs for the following equipment:

- Fiberglass reaction tank;
- Mixer;
- Sulfuric acid feed system;
- Dithiocarbamate feed system;
- Flow equalization tank;
- Effluent pump; and
- pH and ORP meters.

Direct annual costs included operating and maintenance labor and materials, energy costs, and raw materials (e.g., sulfuric acid, dithiocarbamate). EPA based flow dependent costs on the volume of wastewater from chelated-metal-bearing unit operations through the system, before treatment chemicals were added to the flow. The Agency assumed that model sites discharged effluent from this system to the chemical precipitation and sedimentation system. Based on analytical data for these systems, EPA assumed that concentrations of carbon disulfide and dithiocarbamate increased across the system.

11.4.13 Chemical Precipitation

The Agency estimated costs for continuous chemical precipitation systems. EPA costed low-flow systems for model sites with influent flow rates less than or equal to 300 gallons per hour. EPA assumed that the model sites commingled all MP&M wastewater generated for

treatment by this technology, except for wastewater from the Oily Wastes, the Shipbuilding Dry Dock and the Railroad Line Maintenance subcategories, and except for solvent-bearing wastewater which EPA costed for off-site disposal.

The module included capital and annual costs for the following equipment:

- Sulfuric acid feed system (see Section 11.4.5);
- Polymer feed system (see Section 11.4.5);
- Caustic feed system (see Section 11.4.5);
- Equalization tank;
- Rapid-mix tank for precipitation;
- Flocculation tank;
- Final pH-adjustment tank;
- System feed pumps; and
- Rapid and flocculation mixers.

The module assumed that the total suspended solids leaving the chemical precipitation system was equivalent to the sum of influent total suspended solids and the dissolved solids that are converted to suspended solids. The approach for calculating suspended solids from dissolved solids is documented in the public record for this rulemaking. Additional flow from treatment chemical addition was considered negligible. EPA designed the Cost Model to include recycled water from the sludge thickener and filter press. The Agency assumed that model sites discharged effluent from this system to either clarification or microfiltration. Direct annual costs included operating and maintenance labor, energy costs, and raw materials (e.g., sulfuric acid, polymer, caustic).

11.4.14 Slant-Plate Clarifier

The Agency estimated costs for slant-plate (lamella) clarifier systems. EPA costed low-flow systems for model sites with influent flow rates less than or equal to 600 gallons per hour. This system treated effluent from the chemical precipitation system.

The module included capital and annual costs for the following equipment:

- Slant-plate clarifier; and
- One-time 80-hour training cost for operators to meet MP&M clarifier limits instead of the baseline 40 CFR Part 433 Metal Finishing effluent guideline limits.

The Cost Model estimated costs associated with achieving long-term average effluent concentrations for all pollutants treated by chemical precipitation with clarification (see Section 10.3). EPA calculated the amount of sludge generated by this system using site-specific influent pollutant concentration data for the commingled wastewater. The Agency assumed the sludge to be 3 percent solids and costed for discharge to a sludge-thickening tank. EPA assumed

that model sites discharge the effluent from this system to surface water or a POTW. Direct annual costs included maintenance labor and materials. EPA considered operating labor as part of chemical precipitation and accounted for pumps in the chemical precipitation and the sludge-thickening modules.

11.4.15 Multimedia Filtration

The Agency estimated costs for a multimedia filter to continuously remove filterable suspended solids. The system was designed as a polishing step for effluent from the clarifier. Although EPA did not include this technology in the MP&M technology options, it gave treatment in place credit to sites with multimedia filters in place.

The module included capital and annual costs for the following equipment:

- Multimedia filter skid;
- Holding tank for clarifier effluent (clearwell); and
- Media filter feed pump.

EPA assumed pollutant concentrations in the effluent from these systems to be equal to the clarifier long-term average concentrations except for total suspended solids, which was reduced 35 percent across this system based on MP&M sampling data. The Agency assumed filter backwash to be 1.2 percent of the influent flow to the chemical precipitation unit. EPA assumed model sites discharged filtrate from this system to surface water or a POTW. Direct annual costs included operating and maintenance labor and energy costs. EPA incorporated waste disposal costs from solids into the filter press module at sites operating multimedia filters.

11.4.16 Microfiltration for Solids Removal

The Agency estimated costs for continuous chemical precipitation systems followed by microfiltration for solids separation.

The module included capital and annual costs for the following equipment:

- Tubular membrane filtration modules;
- Carbon steel skid;
- Recirculation tank;
- Recirculation pump;
- Air back pulse system;
- Cleaning system;
- Sludge pump; and
- All associated instruments and controls.

Flow rates greater than 406 gallons per minute required multiple systems.

The Cost Model estimated costs associated with achieving long-term average effluent concentrations for all pollutants treated by chemical precipitation followed by microfiltration systems (see Section 10.3). EPA calculated the amount of sludge generated by this system using site-specific influent pollutant concentration data for the commingled wastewater. The Agency assumed the sludge to be 3.2 percent solids and costed for discharge to a sludge-thickening tank. EPA assumed model sites discharged the effluent from this system to surface water or a POTW. Direct annual costs included operating and maintenance labor and materials (e.g., replacement membranes, cleaning chemicals), and energy costs.

11.4.17 Sludge Thickening

The Agency estimated costs for sludge thickening by gravity settling for the sludge discharged from the chemical precipitation and sedimentation system. EPA assumed the sludge-thickening system to discharge 60 percent of influent flow as sludge, thus increasing the solids content of the sludge from 3 percent to 5 percent for clarifier effluent and from 3.2 percent to 5.3 percent for microfiltration effluent prior to further dewatering in the sludge pressure filtration system. The module included capital and annual costs for the following equipment:

- Sludge-thickening unit (package system); and
- Clarified water return pump.

EPA costed for model sites to discharge the sludge from this system to the sludge pressure filtration system. The Agency assumed model sites returned the remaining 40 percent of influent flow back to the chemical precipitation system as supernatant and it included this flow in its design. Direct annual costs included operating and maintenance labor and energy costs.

11.4.18 Sludge Pressure Filtration

The Agency estimated costs for the number of plate-and-frame filter presses needed to increase the solids content of the sludge from approximately 5 percent to 35 percent prior to contract hauling for off-site disposal. The module included capital and annual costs for the following equipment:

- Recessed plate or plate-and-frame filter press; and
- Two double-diaphragm sludge pumps.

Direct annual costs included operating and maintenance labor and sludge disposal costs. The Cost Model assumes model sites discharge the filtrate from this system to the chemical precipitation and sedimentation system.

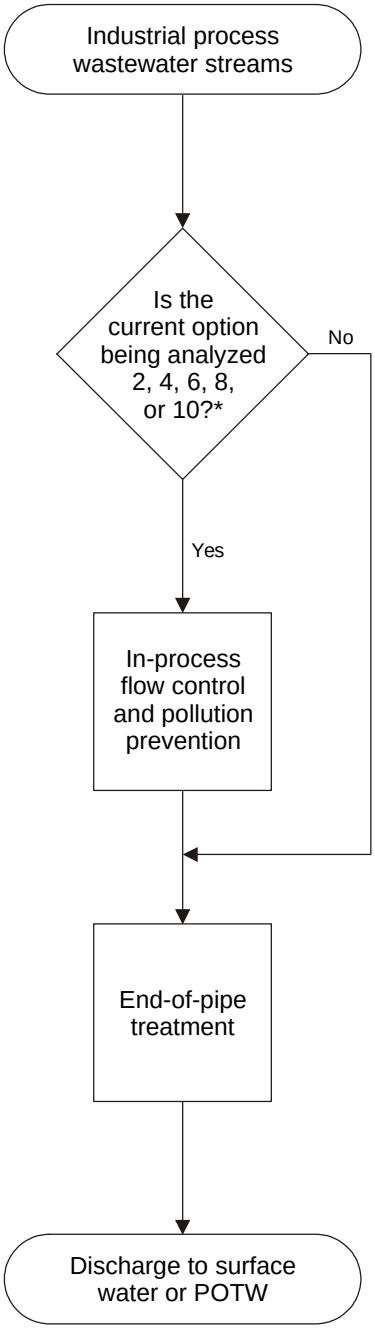
11.5 References

1. U.S. Environmental Protection Agency. Economic, Environmental, & Benefits Analysis of the Proposed Metal Products & Machinery Rule. EPA-821-B-00-008, December 2000.

2. RSMeans Building Construction Cost Data, 56th Annual Edition, 1998, page 594. Historical Cost Indexes.

3. Cushnie, George C., CAI Engineering (prepared for NCMS/NAMF). Pollution Prevention and Control Technology for Plating Operations.

4. U.S. Environmental Protection Agency. MP&M sampling data.



* See Section 9 for descriptions of the 10 technology options.

Figure 11-1. Relationship Between In-Process and End-of-Pipe Technologies and Practices

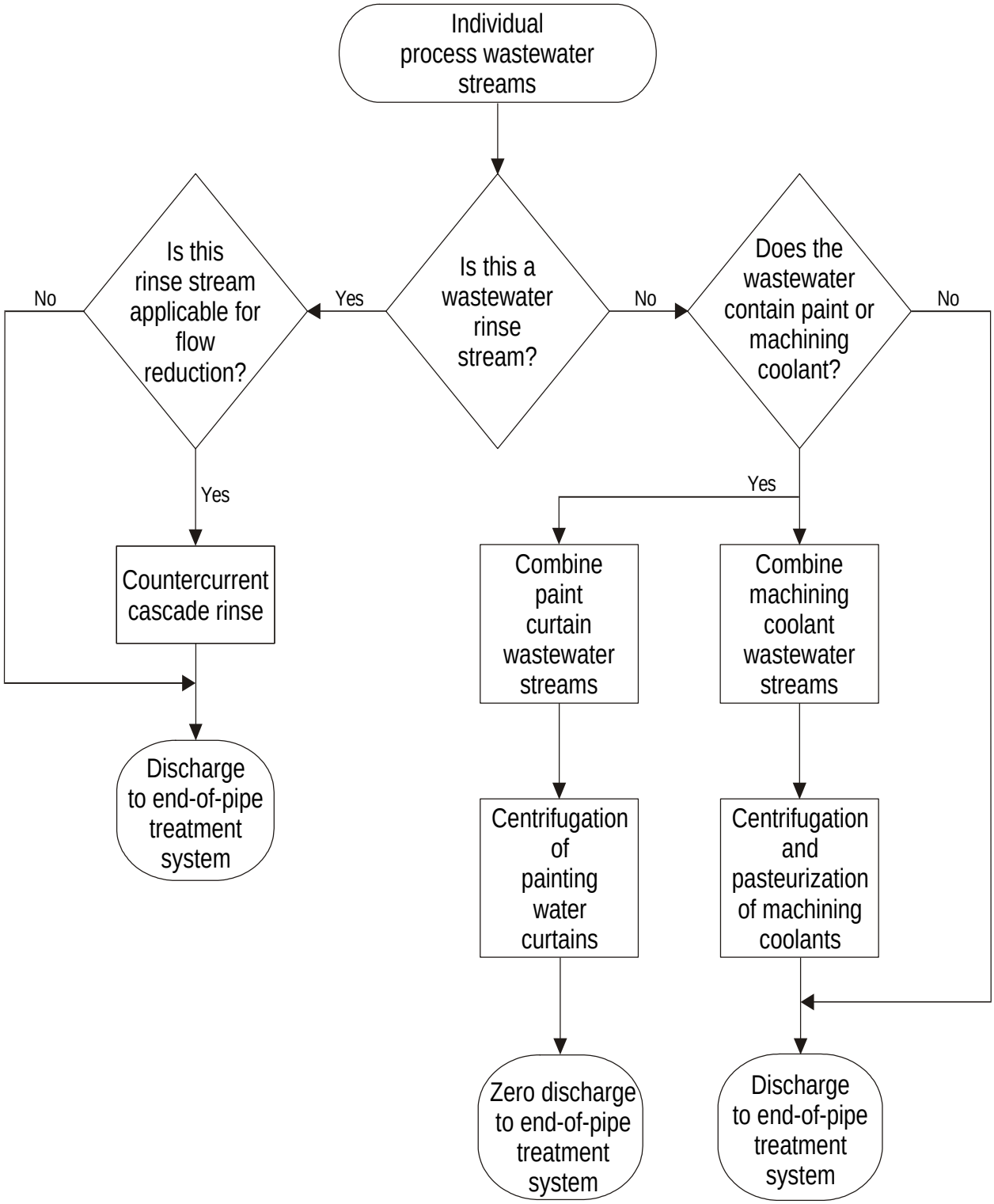


Figure 11-2. Components of Total Capital Investment

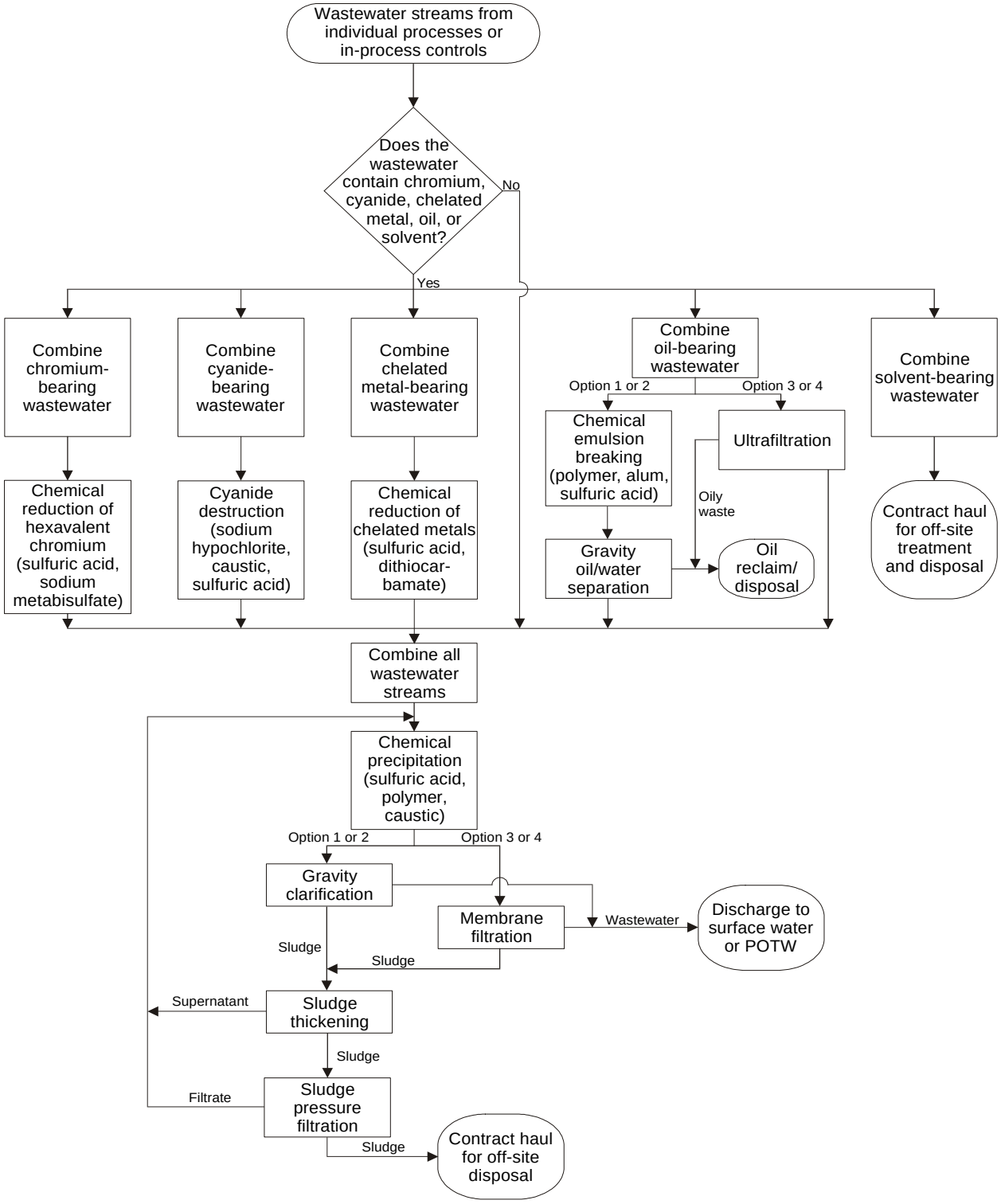
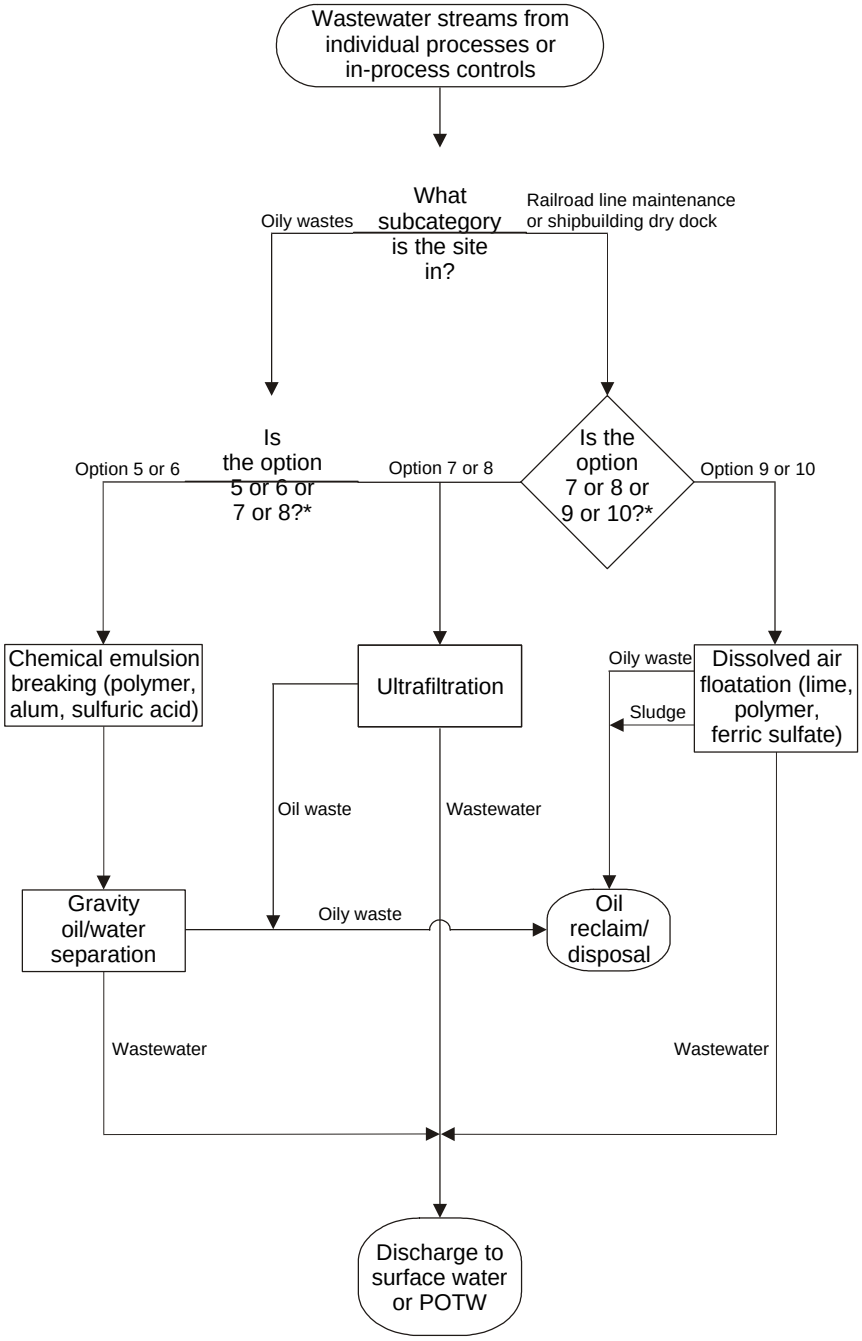


Figure 11-3. Logic Used to Apply End-of-Pipe Technologies and Practices for the Following Subcategories: General Metals, Metal Finishing Job Shops, Non-Chromium Anodizing, Printed Wiring Board, and Steel Forming and Finishing



* See Section 9 for descriptions of the 10 technology options.

Figure 11-4. Logic Used to Apply End-of-Pipe Technologies and Practices for the Following Subcategories: Oily Waste, Railroad Line Maintenance, and Shipbuilding Dry Dock

12.0 POLLUTANT LOADING AND REDUCTION ESTIMATES

This section describes EPA's estimation of industry pollutant loadings and pollutant reductions for each MP&M technology option described in Section 9.0. The Agency estimated pollutant loadings and reductions from MP&M sites to evaluate loadings to surface waters and publicly owned treatment works (POTWs), and to assess the effectiveness of each MP&M technology option in reducing these loadings. An assessment of the water-quality impacts and benefits associated with the reduced pollutant loadings from MP&M facilities as estimated in this section is presented in the report "Economic, Environmental, and Benefits Assessment of the Proposed MP&M Rule." This report is located in the public record for this proposal.

In estimating the pollutant loadings, EPA assumed that all nondetected pollutants of concern are present at the detection limit. EPA did not use the same assumptions in all cases when calculating limits (see Section 10.0). Throughout this section, the terms "sampling point" and "sample" are used as defined below:

> *Sampling Point.* A sampling point is the physical location at which samples are collected. Example sampling points include a wastewater treatment influent stream, an electroplating bath, or a cleaning rinse.
>
> *Sample.* A sample is the unique volume of wastewater collected for analysis at a sampling point. A sample can include several different aliquots collected for analysis of multiple parameters. Each sample represents a unique period of time. EPA typically collected multiple samples from sampling points that represented flowing wastestreams (e.g., wastewater treatment systems, rinses).

Figure 12-1 summarizes the steps used to estimate the MP&M pollutant loadings and reductions for each technology option. These steps are described in Sections 12.1 and 12.2. Section 12.1 describes the calculation of pollutant concentrations for each unit operation. Section 12.2. presents the results of the raw, baseline, and post-compliance pollutant loading and reduction calculations for the industry.

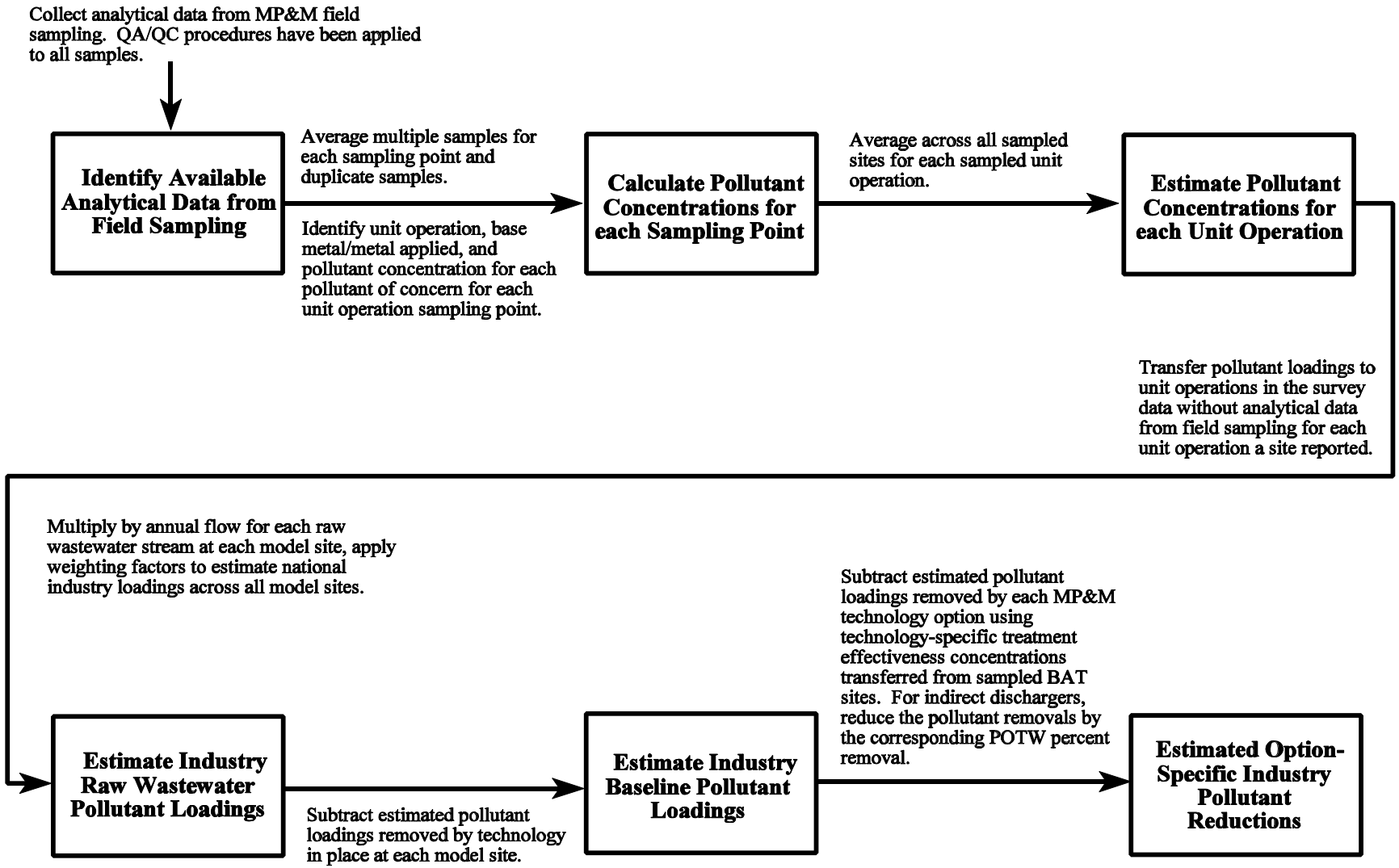


Figure 12-1. Estimation of MP&M Pollutant Loadings and Reductions

12.1 Estimation of Unit Operation Pollutant Concentrations

EPA used data collected during the MP&M sampling program to estimate pollutant concentrations in wastewater streams from each of the MP&M unit operations reported by questionnaire respondents as generating wastewater. EPA developed these estimates for each pollutant of concern (see Section 7.0). These data are included in Sampling Episode Reports (SERs) in the administrative record for this rulemaking. To develop the unit operation concentrations, EPA calculated pollutant concentrations for each sampling point (Section 12.1.1), then calculated the pollutant concentrations for each unit operation (Section 12.1.2).

The first step in estimating pollutant concentrations for each unit operation was to identify unit operations for which pollutant concentrations depend on metal type. This was important when transferring concentrations across unit operations (Section 12.1.2). EPA reviewed the unit operation descriptions and analytical data to identify those unit operations for which pollutant concentrations would be most dependent on metal type processed. While most MP&M unit operations are somewhat dependent on metal type processed, EPA identified two operations (and their associated rinses) for which pollutant concentrations are heavily dependent on metal type: electroplating and electroless plating. In both of these operations and associated rinses, pollutant concentrations depend on the metal type being applied in the operation. For example, chromium electroplating operations and rinses contain higher concentrations of chromium than other metals, while electroless nickel plating operations and rinses contain higher concentrations of nickel than other metals.

12.1.1 Calculate Pollutant Concentrations for Each Sampling Point

EPA developed a pollutant profile (i.e., concentrations for each pollutant of concern) for each sampling point. EPA used the following approach to calculate pollutant concentrations for each sampling point:

- *Average duplicate sample concentrations.* As discussed in Section 4.0, EPA collected duplicate samples at many sampling points as a quality control measure. EPA averaged the concentrations for the original and duplicate samples.

- *Average multiple sample concentrations for each sampling point.* At sampling points representing flowing wastewater streams (e.g., rinses), EPA typically collected multiple samples over time. EPA collected these samples to account for variability over time of the discharges from these streams. EPA averaged the concentrations for the samples collected on multiple days at the same sampling point. For example, if EPA collected three one-day composite samples for acid treatment rinsing at the same sampling point, it averaged the concentrations for each pollutant on each of the three days to estimate the pollutant concentration for the sampling point.

12.1.2 Estimate Pollutant Concentrations for Each Unit Operation

EPA estimated pollutant concentrations for each unit operation reported in the MP&M detailed surveys. For electroplating and electroless plating operations, EPA estimated concentrations for each unit operation and metal type combination reported in the surveys. EPA used the following steps to estimate the pollutant concentrations:

- *Identify all unit operations reported in the detailed surveys.* EPA queried the MP&M detailed survey database to identify all unit operations reported as discharging wastewater, as well as all unit operation and metal type combinations (based on applied metal) for electroplating and electroless plating. EPA considered unit operations performed at facilities in the Non-chromium Anodizing subcategory to be unique from unit operations performed in other subcategories because the non-chromium anodizing process primarily aluminum and perform a limited subset of unit operations, as described in Section 6.2.4. Therefore, EPA developed unique pollutant concentrations for operations performed at Non-chromium Anodizing facilities.

- *Estimate pollutant concentrations for each unit operation for which sampling analytical data are available.* EPA averaged the pollutant concentrations for each unit operation and each unit operation and metal type combination (for electroplating and electroless plating) across sites. For example, EPA averaged the site-level pollutant concentrations for all acid cleaning operations.

- *Transfer data to unit operations for which sampling data are not available.* The final step in estimating unit operation pollutant concentrations consisted of transferring data to unit operations for which EPA did not collect sampling data. EPA transferred pollutant concentrations from unit operations expected to have similar wastewater characteristics based on process considerations, including the following: the purpose of the unit operation (e.g., metal removal, contaminant removal); the purpose of the process water use (e.g., contact cooling water, cleaning solution, rinsewater); and the wastewater flow per unit of production as reported in the MP&M surveys. Supporting documentation for all data transfers of unit operation pollutant concentrations is contained in the administrative record for this rulemaking.

12.2 Calculation of Industry Pollutant Loadings and Reductions

EPA estimated the pollutant loadings for each pollutant of concern for each wastewater discharging unit operation at each model site (model site development is described in Section 11.2). EPA estimated industry-wide raw wastewater pollutant loadings, baseline

pollutant loadings, and option-specific loadings for each MP&M technology option as described in Sections 12.2.1 through 12.2.3. EPA subtracted the option-specific post-compliance pollutant loading estimates from the baseline loadings to estimate pollutant reductions for each option.

12.2.1 Industry Raw Wastewater Pollutant Loadings

Industry raw wastewater pollutant loadings represent the industry pollutant loadings before removal by treatment technologies currently in place at MP&M sites. EPA used the following steps to estimate the raw wastewater loadings:

- *Estimate site-specific raw wastewater pollutant loadings.* For each wastewater discharging unit operation at each model site, EPA multiplied the unit operation concentrations by its wastewater flow rate (as reported in the questionnaire) to obtain a mass loading. EPA then summed the loadings for each pollutant across all unit operations performed at each model site to develop a site-specific raw wastewater pollutant loading.

- *Estimate industry-wide raw wastewater pollutant loadings.* EPA multiplied the site-specific raw wastewater pollutant loadings for each pollutant of concern by the corresponding site-specific statistically derived weighting factors discussed in the report "Statistical Summary for the MP&M Industry Surveys." EPA summed the weighted loadings across all sites in each subcategory to develop subcategory-specific raw wastewater pollutant loadings. EPA also summed the weighted loadings across all sites to develop industry-wide raw wastewater pollutant loadings.

Tables 12-1 and 12-2 present the results of the estimation for industry raw wastewater annual pollutant loadings by subcategory for direct and indirect dischargers, respectively.

12.2.2 Industry Baseline Pollutant Loadings

Industry baseline pollutant loadings represent the industry pollutant loadings after accounting for pollutant removals by technologies already in place at MP&M sites. Section 11.0 describes the assessment of technology in place for each model site. EPA used the following steps to estimate the baseline pollutant loadings:

- *Estimate site-specific baseline pollutant loadings.* EPA performed a baseline run of the MP&M Design and Cost Model to estimate site-specific baseline pollutant loadings for each model site. The baseline run used the technologies in place at each site rather than the MP&M technology options. EPA estimated the site-specific baseline loadings as the pollutants being discharged after the application of the treatment technologies currently in place at model sites.

- *Estimate industry-wide baseline pollutant loadings.* EPA multiplied the site-specific baseline pollutant loadings for each pollutant of concern by the corresponding site-specific statistically-derived weighting factors discussed in the report "Statistical Summary for the MP&M Industry Surveys." EPA summed the weighted loadings across all sites in each subcategory to develop subcategory-specific baseline pollutant loadings. EPA also summed the weighted loadings across all sites to develop industry-wide baseline pollutant loadings.

Tables 12-1 and 12-2 present the results of the estimation for industry baseline pollutant loadings by subcategory for direct and indirect dischargers, respectively.

12.2.3 Option-Specific Industry Pollutant Loadings and Pollutant Reductions

Option-specific pollutant loadings (i.e., post-compliance pollutant loadings for each technology option) represent the total industry pollutant loadings after the application of each MP&M technology option. Option-specific pollutant reductions represent the total industry pollutant removals for each technology option. EPA estimated option-specific loadings and reductions as follows:

- *Estimate site-specific, option-specific pollutant loadings.* EPA used the MP&M Design and Cost Model (see Section 11.0) to estimate pollutant loadings for each site for each technology option.

- *Estimate site-specific, option-specific pollutant removals.* EPA estimated the option-specific pollutant removals as the difference between the site-specific baseline pollutant loadings and the option-specific pollutant loadings. For indirect dischargers, EPA then reduced the site-specific, option-specific pollutant removals by their corresponding POTW percent removal (see Table 12-3) to account for treatment that will occur at the POTW.

- *Estimate industry-wide, option-specific pollutant loadings and removals.* For each option, EPA multiplied the site-specific pollutant loadings and removals (accounting for POTW removals for indirect dischargers) for each pollutant of concern by the corresponding site-specific statistically-derived weighting factors discussed in the report "Statistical Summary for the MP&M Industry Surveys." EPA summed the weighted loadings and removals across all sites in each subcategory to develop subcategory-specific pollutant loadings and removals. EPA also summed the weighted loadings and removals across all sites to develop industry-wide pollutant loadings and reductions.

Tables 12-2 and 12-3 present the estimated Selected Option pollutant loadings by subcategory for direct and indirect dischargers, respectively. Tables 12-4 and 12-5 present the estimated pollutant removals by the Selected Option for direct and indirect dischargers, respectively. Tables 12-6 through 12-20 present the top pollutants removed (in toxic pound equivalents) by the Selected Option by subcategory for direct and indirect dischargers.

Table 12-1

Summary of Annual Pollutant Loadings for MP&M Direct Dischargers by Subcategory

Subcategory	Total No. of Sites	Industry Raw Wastewater Pollutant Loadings (a)			Baseline Pollutant Loadings (b)			Selected Option Pollutant Loadings (c)		
			(lbs/yr)			(lbs/yr)			(lbs/yr)	
		(lbs-eq/yr)	Priority & Nonconventional Metals/ Organics(d)	TSS/Oil and Grease (as HEM)	(lbs-eq/yr)	Priority & Nonconventional Metals/ Organics(d)	TSS/Oil and Grease (as HEM)	(lbs-eq/yr)	Priority & Nonconventional Metals/ Organics(d)	TSS/Oil and Grease (as HEM)
General Metals	3,784	6,521,910	46,976,587	115,775,867	1,248,018	10,653,897	19,050,051	133,429	1,420,008	1,161,143
Metal Finishing Job Shops	16	34,622	151,584	261,057	15,672	56,102	38,319	1,608	11,992	10,776
Non-Chromium Anodizing (e)	-	-	-	-	-	-	-	-	-	-
Printed Wiring Board	12	249,276	1,167,185	729,629	59,340	278,370	362,431	11,922	83,015	73,770
Steel Forming and Finishing	43	3,327,437	23,205,748	11,374,652	124,972	941,572	1,276,363	208,877	630,756	38,891,453
Oily Wastes	912	81,407	1,639,048	12,343,318	21,060	730,372	1,378,666	22,535	661,310	356,912
Railroad Line Maintenance (f)	34	2,145	187,605	990,500	1,128	55,611	70,158	1,267	179,157	16,021
Shipbuilding Dry Dock	6	27,903	3,393,475	8,946,211	1,815	94,772	8,515,131	1,896	95,936	102,502

Source: MP&M pollutant loadings.
(a) These raw loads do not reflect treatment currently in place.
(b) These baseline loads reflect treatment currently in place.
(c) These loads reflect the load after the implementation of the MP&M technology basis for each subcategory.
(d) Does not include sodium, calcium, total dissolved solids, and potassium.
(e) EPA's data collection efforts did not identify any direct discharging non-chromium anodizing facilities.
(f) The baseline and the Selected Option pollutant loadings for BOD_5 for Railroad Line Maintenance is 59,814 and 57,150 lbs/yr, respectively.

Table 12-2

Summary of Annual Pollutant Loadings for MP&M Indirect Dischargers by Subcategory[a]

Subcategory	Total No. of Sites	Industry Raw Wastewater Pollutant Loadings (b)			Baseline Pollutant Loadings (c)			Selected Option Pollutant Loadings (d,e)		
			(lbs/yr)			(lbs/yr)			(lbs/yr)	
		(lbs-eq/yr)	Priority & Nonconventional Metals/ Organics (f)	TSS/Oil and Grease (as HEM)	(lbs-eq/yr)	Priority & Nonconventional Metals/ Organics (f)	TSS/Oil and Grease (as HEM)	(lbs-eq/yr)	Priority & Nonconventional Metals/ Organics (f)	TSS/Oil and Grease (as HEM)
General Metals	26,195	116,275,842	555,129,426	737,700,419	23,804,767	155,478,167	398,844,708	1,241,465	11,732,601	11,082,451
Metal Finishing Job Shops	1,515	20,417,884	38,428,372	15,780,889	5,598,845	12,741,874	10,406,023	118,988	1,015,185	813,455
Non-Chromium Anodizing	191	122,359	869,757	1,718,224	117,647	808,018	1,473,802	NR	NR	NR
Printed Wiring Board	621	5,732,973	21,773,732	26,175,775	2,727,103	9,103,518	20,019,186	149,959	1,226,487	941,657
Steel Forming and Finishing	111	1,248,907	9,120,891	6,328,042	400,524	2,667,746	1,045,957	104,606	336,249	22,531,113
Oily Wastes	28,514	1,002,116	17,206,229	75,298,418	496,626	13,396,099	24,366,355	506,597	3,333,132	4,822,848
Railroad Line Maintenance	799	3,794	40,084	10,463,731	1,712	14,759	71,136	NR	NR	NR
Shipbuilding Dry Dock	6	397	38,542	13,482	257	25,984	5,356	NR	NR	NR

Source: MP&M pollutant loadings.
NR - Not regulated. EPA is not proposing to regulate these sites under the MP&M rule.
(a) These loads do not reflect removals by publicly owned treatment works (see Table 12-4 for incorporation of POTW removals).
(b) These raw loads do not reflect treatment currently in place.
(c) These baseline loads reflect treatment currently in place.
(d) These loads include only those for the regulated sites; this accounts for 3,056 General Metals facilities discharging greater than 1 MGY and 226 Oily Wastes facilities discharging greater than 2 MGY.
(e) These loads reflect the load after the implementation of the MP&M technology basis for each subcategory.
(f) Does not include sodium, calcium, total dissolved solids, and potassium.

Table 12-3

Publicly Owned Treatment Works (POTW) Removal Percents For Each MP&M Pollutants of Concern

Chemical Name	POTW Removal Percent	Source[a-c]
1,1,1-Trichloroethane	90.45	a
1,1-Dichloroethane	70	a
1,1-Dichloroethene	77.51	c
1,4-Dioxane	45.8	b
1-Bromo-2-Chlorobenzene	77.32	c
1-Bromo-3-Chlorobenzene	77.32	c
1-Methylfluorene	84.55	b
1-Methylphenanthrene	84.55	b
2,4-Dimethylphenol	77.51	c
2,4-Dinitrophenol	77.51	c
2,6-Dinitrotoluene	77.51	c
2-Butanone	96.6	b
2-Hexanone	77.32	c
2-Isopropylnaphthalene	77.32	c
2-Methylnaphthalene	28	b
2-Nitrophenol	26.83	a
2-Propanone	83.75	b
3,6-Dimethylphenanthrene	84.55	b
4-Chloro-3-Methylphenol	63	b
4-Methyl-2-Pentanone	87.87	b
4-Nitrophenol	77.51	c
Acenaphthene	98.29	a
Acetophenone	95.34	b
Acrolein	77.51	c
Alpha-Terpineol	94.4	b
Aluminum	91.36	a
Amenable Cyanide	57.41	c
Ammonia As Nitrogen	38.94	a
Aniline	93.41	b

Table 12-3 (Continued)

Chemical Name	POTW Removal Percent	Source[a-c]
Anthracene	77.51	c
Antimony	66.78	a
Arsenic	65.77	a
Barium	15.98	a
Benzoic Acid	80.5	b
Benzyl Alcohol	78	b
Beryllium	71.66	c
Biphenyl	96.28	b
Bis(2-Ethylhexyl) Phthalate	59.78	a
Bod 5-Day (Carbonaceous)	89.12	a
Boron	30.42	a
Butyl Benzyl Phthalate	81.65	a
Cadmium	90.05	a
Calcium	8.54	a
Carbon Disulfide	84	b
Chemical Oxygen Demand (COD)	81.3	a
Chloride	57.41	c
Chlorobenzene	96.37	a
Chloroethane	77.51	c
Chloroform	73.44	a
Chromium	80.33	a
Cobalt	6.11	a
Copper	84.2	a
Cyanide	70.44	a
Di-N-Butyl Phthalate	84.66	a
Di-N-Octyl Phthalate	68.43	a
Dibenzofuran	77.32	c
Dibenzothiophene	84.68	b
Dimethyl Phthalate	77.51	c
Diphenyl Ether	77.32	c
Diphenylamine	77.32	c
Ethylbenzene	93.79	a

Table 12-3 (Continued)

Chemical Name	POTW Removal Percent	Source[a-c]
Fluoranthene	42.46	a
Fluorene	69.85	a
Fluoride	61.35	
Gold	32.52	c
Hexanoic Acid	84	b
Hexavalent Chromium	57.41	c
Iron	81.99	a
Isobutyl Alcohol	28	b
Isophorone	77.51	c
Lead	77.45	a
M+P Xylene	77.32	c
M-Xylene	95.07	b
Magnesium	14.14	a
Manganese	35.51	a
Mercury	71.66	c
Methyl Methacrylate	99.96	b
Methylene Chloride	54.28	a
Molybdenum	18.93	a
N,N-Dimethylformamide	87	b
N-Decane	9	b
N-Docosane	88	b
N-Dodecane	95.05	b
N-Eicosane	92.4	b
N-Hexacosane	71.11	b
N-Hexadecane	71.11	b
N-Nitrosodimethylamine	77.51	c
N-Nitrosodiphenylamine	90.11	b
N-Nitrosopiperidine	77.32	c
N-Octacosane	71.11	b
N-Octadecane	71.11	b
N-Tetracosane	71.11	b
N-Tetradecane	71.11	b

Table 12-3 (Continued)

Chemical Name	POTW Removal Percent	Source[a-c]
N-Triacontane	77.32	c
Naphthalene	94.69	a
Nickel	51.44	a
O+P Xylene	65.4	b
O-Cresol	52.5	b
O-Xylene	77.32	c
Oil And Grease (As HEM)	86.08	a
P-Cresol	71.67	b
P-Cymene	99.79	b
Phenanthrene	94.89	a
Phenol	95.25	a
Phosphorus	32.52	c
Pyrene	83.9	b
Pyridine	95.4	b
Selenium	34.33	b
Silver	88.28	a
Sodium	2.69	a
Styrene	93.65	b
Sulfate	84.61	b
Tetrachloroethene	84.61	a
Thallium	71.66	c
Tin	42	a
Titanium	91.82	a
Toluene	96.18	a
Total Dissolved Solids	8	b
Total Kjeldahl Nitrogen	57.41	c
Total Organic Carbon (TOC)	70.28	a
Total Petroleum Hydrocarbons (As SGT-HEM)	57.41	c
Total Phosphorus	57.41	c
Total Recoverable Phenolics	57.41	c
Total Sulfide	57.41	c
Total Suspended Solids	89.55	a

Table 12-3 (Continued)

Chemical Name	POTW Removal Percent	Source[a-c]
Trichloroethene	77.51	c
Trichlorofluoromethane	77.32	c
Tripropyleneglycol Methyl Ether	52.4	b
Vanadium	9.51	a
Weak-Acid Dissociable Cyanide	57.41	c
Yttrium	32.52	c
Zinc	79.14	a

Note: See public record for further detail for the sources.
[a] November 5, 1999 Updated 50-POTW Study. Influent Concentration 10xML, 5xML, then 20 ppb.
[b] RREL Database. Compiled for the CWT effluent guideline or the 1995 Phase I Proposal.
[c] Average POTW removals calculated by classification code from sources a and b.

Table 12-4

Summary of Annual Pollutant Reductions for MP&M Direct Dischargers by Subcategory [a,b]

Subcategory	Total No. of Regulated Sites	Baseline Pollutant Loadings		Pollutant Removals by Selected Option		% Reduction from Baseline (lb-eq/yr)
		lb-eq/yr	lbs/yr (c)	lb-eq/yr	lbs/yr (c)	
General Metals	3,795	1,248,018	29,703,949	1,123,797	27,224,783	90.0%
Metal Finishing Job Shops	16	15,672	94,422	14,377	71,766	91.7%
Non-Chromium Anodizer	NA (d)	-	-	-	-	-
Printed Wiring Board	12	59,340	640,801	48,366	485,395	81.5%
Steel Forming and Finishing	43	124,972	2,217,935	85,070	1,448,450	68.1%
Oily Wastes	912	21,060	2,109,039	9,899	1,441,671	47.0%
Railroad Line Maintenance	34	1,128	125,770	154	57,538	13.6%
Shipbuilding Dry Dock	6	1,815	8,609,903	111	8,453,293	6.1%

Source: MP&M pollutant loadings.
(a) Pollutant loadings and removal estimates presented in this table will not equate with those presented in the Cost-Effectiveness Analysis and the EEBA. The estimates in those documents do not include pollutant loadings from facilities that are projected to close in the baseline.
(b) See Tables 12-6 through 12-12 for pollutant-specific removals by subcategory.
(c) Does not include sodium, calcium, total dissolved solids, chemical oxygen demand, and potassium.
(d) EPA's data collection efforts did not identify any direct discharging non-chromium anodizing facilities.

Table 12-5

Summary of Annual Pollutant Reductions for MP&M Indirect Dischargers by Subcategory [a,b]

Subcategory	Total No. of Regulated Sites	Baseline Pollutant Loadings		Pollutant Removals by Selected Option (c)		% Reduction from Baseline (lb-eq/yr)
		lb-eq/yr	lbs/yr (d)	lb-eq/yr	lbs/yr (d)	
General Metals	3,795	21,859,748	508,792,176	5,513,689	75,222,259	25.2%
Metal Finishing Job Shops	16	5,598,845	23,147,897	1,626,502	4,595,928	29.1%
Non-Chromium Anodizer	NA (e)	-	-	-	-	-
Printed Wiring Board	12	2,727,103	29,122,704	920,640	5,128,256	33.8%
Steel Forming and Finishing	43	400,524	3,713,703	115,624	731,264	28.9%
Oily Wastes	912	257,894	12,942,097	36,866	1,471,328	14.3%
Railroad Line Maintenance	NA (4)	-	-	-	-	-
Shipbuilding Dry Dock	NA (4)	-	-	-	-	-

Source: MP&M pollutant loadings.
(a) Pollutant loadings and removal estimates presented in this table will not equate with those presented in the Cost-Effectiveness Analysis and the EEBA. The estimates in those documents do not include pollutant loadings from facilities that are projected to close in the baseline.
(b) See Tables 12-13 through 12-20 for pollutant-specific removals for each subcategory.
(c) These removals account for removals by publicly owned treatment works for each pollutant for the Selected Option.
(d) Does not include sodium, calcium, total dissolved solids, chemical oxygen demand and potassium.
(e) EPA is not proposing pretreatment standards for these subcategories.

Table 12-6

Top Pollutants Removed by Proposed Option for General Metals Direct Dischargers

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
TOTAL SULFIDE	421,356	150,484
TIN	251,019	836,729
COPPER	242,366	384,707
CYANIDE	202,008	183,644
SILVER	119,080	7,442
BORON	82,034	455,746
LEAD	62,838	28,563
MOLYBDENUM	25,118	125,590
ALUMINUM	19,104	298,496
ZINC	15,234	324,130
ANTHRACENE	14,466	5,786
NICKEL	14,075	127,953
CHROMIUM	10,602	139,495
CADMIUM	10,317	3,968
HEXAVALENT CHROMIUM	8,309	16,293
MANGANESE	7,814	111,630
ANILINE	7,640	5,457
IRON	5,338	953,206
FLUORANTHENE	4,643	5,804
FLUORIDE	4,496	128,464
FLUORENE	4,051	5,787
BIS(2-ETHYLHEXYL) PHTHALATE	3,080	32,421
ACROLEIN	3,076	3,171
N-NITROSODIMETHYLAMINE	1,771	25,302
PHENANTHRENE	1,703	5,873
3,6-DIMETHYLPHENANTHRENE	1,596	5,910
CARBON DISULFIDE	1,482	529
DI-N-OCTYL PHTHALATE	1,272	5,781
DIBENZOFURAN	1,091	5,455

Table 12-6 (Continued)

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
BENZOIC ACID	997	3,019,908
SELENIUM	910	827
AMMONIA AS NITROGEN	817	326,833
2,6-DINITROTOLUENE	645	6,449
PYRENE	637	5,786
N-TETRADECANE	619	143,925
1-METHYLPHENANTHRENE	610	6,102
ARSENIC	543	155

Source: MP&M pollutant loadings.

Table 12-7

Top Pollutants Removed by Proposed Option for Metal Finishing Job Shops Direct Dischargers

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
CYANIDE	6,257	5,688
TIN	3,508	11,694
COPPER	2,496	3,962
TOTAL SULFIDE	2,133	762
NICKEL	585	5,316
BORON	356	1,976
CHROMIUM	246	3,239
LEAD	179	81
ANTHRACENE	157	63
ZINC	94	2,008
ANILINE	88	63
HEXAVALENT CHROMIUM	77	150
FLUORANTHENE	50	63
FLUORENE	44	63
ACROLEIN	39	40
SILVER	37	2
MOLYBDENUM	35	174
ALUMINUM	30	475
PHENANTHRENE	18	63
3,6-DIMETHYLPHENANTHRENE	17	64
IRON	17	3,038
DI-N-OCTYL PHTHALATE	14	63
DIBENZOFURAN	13	63
MANGANESE	11	154
CADMIUM	9	4
FLUORIDE	8	215
BIS(2-ETHYLHEXYL) PHTHALATE	7	74
N-NITROSODIMETHYLAMINE	7	100
PYRENE	7	63
AMMONIA AS NITROGEN	7	2,756

Table 12-7 (Continued)

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
2,6-DINITROTOLUENE	6	65
1-METHYLPHENANTHRENE	6	65
2-METHYLNAPHTHALENE	5	61
2-ISOPROPYLNAPHTHALENE	5	66
N-NITROSODIPHENYLAMINE	4	102
1-METHYLFLUORENE	3	62
DIBENZOTHIOPHENE	3	63

Source: MP&M pollutant loadings.

Table 12-8

Top Pollutants Removed by Proposed Option for Printed Wiring Board Direct Dischargers

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
TIN	23,886	79,619
TOTAL SULFIDE	16,121	5,757
COPPER	14,562	23,114
CARBON DISULFIDE	3,311	1,183
NICKEL	2,155	19,593
CYANIDE	1,487	1,351
LEAD	1,013	460
BORON	623	3,460
ZINC	263	5,594
ALUMINUM	208	3,244
IRON	176	31,420
MOLYBDENUM	155	774
CHROMIUM	146	1,926
MANGANESE	76	1,083
SILVER	57	4
ACROLEIN	56	57
ANTHRACENE	43	17
AMMONIA AS NITROGEN	43	17,090
FLUORIDE	30	870
ARSENIC	26	7
ANILINE	24	17
FLUORANTHENE	14	17
FLUORENE	12	17
TITANIUM	10	335
COBALT	7	59
N-NITROSODIMETHYLAMINE	6	88
BENZOIC ACID	6	17,689
PHENANTHRENE	5	17
BIS(2-ETHYLHEXYL) PHTHALATE	5	50
3,6-DIMETHYLPHENANTHRENE	5	17
DI-N-OCTYL PHTHALATE	4	17
DIBENZOFURAN	3	17
1,1-DICHLOROETHENE	3	16
SULFATE	3	474,868

Source: MP&M pollutant loadings.

Table 12-9

Top Pollutants Removed by Proposed Option for Steel Forming and Finishing Direct Dischargers

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
TOTAL SULFIDE	252,728	90,260
TIN	29,991	99,970
COPPER	23,848	37,854
BORON	11,125	61,804
LEAD	4,515	2,052
NICKEL	2,365	21,501
SILVER	2,209	138
ALUMINUM	1,899	29,672
CYANIDE	1,228	1,116
CHROMIUM	1,117	14,701
FLUORIDE	924	26,392
ACROLEIN	911	939
ANTHRACENE	864	346
ZINC	843	17,935
CARBON DISULFIDE	575	205
ANILINE	438	313
MOLYBDENUM	298	1,490
MANGANESE	293	4,193
FLUORANTHENE	273	342
ARSENIC	250	71
FLUORENE	239	342
VANADIUM	214	346
SELENIUM	172	156
AMMONIA AS NITROGEN	160	64,119
IRON	132	23,646
CHLORIDE	119	4,939,545
N-NITROSODIMETHYLAMINE	111	1,588
3,6-DIMETHYLPHENANTHRENE	107	398

Table 12-9 (Continued)

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
MERCURY	103	1
PHENANTHRENE	103	353
BIS(2-ETHYLHEXYL) PHTHALATE	94	984
DI-N-OCTYL PHTHALATE	75	341
DIBENZOFURAN	63	313
MAGNESIUM	59	67,510
HEXAVALENT CHROMIUM	51	100
2,6-DINITROTOLUENE	50	500

Source: MP&M pollutant loadings.

Table 12-10

Top Pollutants Removed by Proposed Option for Oily Wastes Direct Dischargers

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
TOTAL SULFIDE	6,141	2,193
LEAD	1,973	897
BORON	1,556	8,643
COPPER	1,160	1,842
MOLYBDENUM	865	4,325
SILVER	823	51
CADMIUM	709	273
ANTHRACENE	646	258
ALUMINUM	312	4,870
ANILINE	288	206
FLUORANTHENE	207	259
IRON	196	34,979
FLUORENE	181	258
ZINC	170	3,607
PHENANTHRENE	77	266
ACROLEIN	64	66
3,6-DIMETHYLPHENANTHRENE	63	235
DI-N-OCTYL PHTHALATE	63	285
N-NITROSODIMETHYLAMINE	56	800
DIBENZOFURAN	41	206
NICKEL	36	325
BENZOIC ACID	36	108,125
BIS(2-ETHYLHEXYL) PHTHALATE	35	372
2,6-DINITROTOLUENE	29	289
PYRENE	28	258
TIN	21	71
ARSENIC	20	6
2-ISOPROPYLNAPHTHALENE	20	271
MAGNESIUM	18	20,363
FLUORIDE	17	487
N-NITROSODIPHENYLAMINE	17	421
2-METHYLNAPHTHALENE	16	202
CHROMIUM	16	207
1-METHYLPHENANTHRENE	13	127
MANGANESE	12	170

Source: MP&M pollutant loadings.

Table 12-11

Top Pollutants Removed by Proposed Option for Railroad Line Maintenance Direct Dischargers

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
BORON	87	485
LEAD	24	11
TOTAL SULFIDE	21	7.332
ALUMINUM	9.036	141
SILVER	7.803	0.488
TIN	5.876	20
CADMIUM	4.975	1.914
COPPER	4.541	7.208
IRON	1.746	312
ZINC	1.551	33
MANGANESE	1.396	20
ANTHRACENE	0.909	0.364
ANILINE	0.868	0.620
MOLYBDENUM	0.490	2.451
CHROMIUM	0.490	6.443
NICKEL	0.296	2.695
FLUORANTHENE	0.291	0.364
N-NITROSODIMETHYLAMINE	0.279	3.982
FLUORENE	0.255	0.364
TITANIUM	0.197	6.777
3,6-DIMETHYLPHENANTHRENE	0.181	0.672
2-METHYLNAPHTHALENE	0.128	1.598
DIBENZOFURAN	0.124	0.620
PHENANTHRENE	0.107	0.368
1-METHYLPHENANTHRENE	0.100	1.003
BIS(2-ETHYLHEXYL) PHTHALATE	0.082	0.860
VANADIUM	0.068	0.110
2-ISOPROPYLNAPHTHALENE	0.058	0.799
N-NITROSODIPHENYLAMINE	0.051	1.268
DI-N-OCTYL PHTHALATE	0.050	0.228

Source: MP&M pollutant loadings.

Table 12-12

Top Pollutants Removed by Proposed Option for Shipbuilding Dry Dock Direct Dischargers

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
CHROMIUM	63	832
MANGANESE	36	515
NICKEL	7.71	70
MOLYBDENUM	3.53	17.64
BENZOIC ACID	0.235	712
1-METHYLPHENANTHRENE	0.041	0.409

Source: MP&M pollutant loadings.

Table 12-13

Top Pollutants Removed by Proposed Option for General Metals Indirect Dischargers[a]

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
COPPER	1,792,625	2,845,436
TOTAL SULFIDE	1,383,215	494,006
TIN	1,212,529	4,041,764
BORON	559,185	3,106,581
LEAD	527,231	239,651
NICKEL	315,515	2,868,315
CYANIDE	312,109	283,735
MOLYBDENUM	241,330	1,206,652
MANGANESE	229,618	3,280,260
FLUORIDE	126,412	3,611,778
VANADIUM	57,919	93,417
ZINC	44,761	952,356
CHROMIUM	42,165	554,801
ALUMINUM	40,314	629,903
IRON	34,230	6,112,555
SILVER	26,973	1,686
ANTHRACENE	11,743	4,697
CADMIUM	10,250	3,942
AMMONIA AS NITROGEN	10,126	4,050,566
FLUORANTHENE	9,817	12,271
ARSENIC	4,871	1,392
COBALT	4,444	40,402
FLUORENE	4,423	6,319
SELENIUM	4,179	3,800
HEXAVALENT CHROMIUM	3,380	6,628
ACROLEIN	2,665	2,748
TITANIUM	2,577	88,874
BIS(2-ETHYLHEXYL) PHTHALATE	2,531	26,643
BENZOIC ACID	2,180	6,607,285
ANILINE	1,792	1,280
MAGNESIUM	1,787	2,053,495
CARBON DISULFIDE	1,714	612

Table 12-13 (continued)

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
CHLORIDE	1,594	66,435,600
DI-N-OCTYL PHTHALATE	1,481	6,731
N-NITROSODIMETHYLAMINE	1,447	20,669
2-METHYLNAPHTHALENE	1,290	16,126
3,6-DIMETHYLPHENANTHRENE	954	3,532
THALLIUM	923	923
DIBENZOFURAN	872	4,358
2,6-DINITROTOLUENE	569	5,693

Source: MP&M pollutant loadings.
(a) The Proposed Option for General Metals indirect dischargers includes only those facilities that discharge greater than 1 MGY of process wastewater.

Table 12-14

Top Pollutants Removed by Proposed Option for Metal Finishing Job Shops Indirect Dischargers

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
CYANIDE	1,113,405	1,012,187
TIN	242,337	807,789
COPPER	148,476	235,676
TOTAL SULFIDE	122,061	43,593
BORON	44,719	248,436
NICKEL	25,840	234,910
LEAD	11,537	5,244
CHROMIUM	7,741	101,853
MANGANESE	7,186	102,654
FLUORIDE	5,055	144,432
SILVER	4,598	287
ZINC	4,149	88,282
CADMIUM	3,681	1,416
IRON	2,930	523,164
MOLYBDENUM	2,700	13,498
CARBON DISULFIDE	2,647	945
HEXAVALENT CHROMIUM	1,266	2,483
ALUMINUM	1,219	19,053
AMMONIA AS NITROGEN	964	385,723
VANADIUM	605	977
ANTHRACENE	440	176
FLUORANTHENE	360	450
ARSENIC	277	79
ACROLEIN	272	280
THALLIUM	185	185
FLUORENE	165	236
COBALT	164	1,488
CHLORIDE	150	6,256,880
SELENIUM	92	84
BIS(2-ETHYLHEXYL) PHTHALATE	81	851

Table 12-14 (Continued)

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
TITANIUM	78	2,676
ANILINE	71	51
MAGNESIUM	59	68,292
N-NITROSODIMETHYLAMINE	58	832
2-METHYLNAPHTHALENE	56	695
DI-N-OCTYL PHTHALATE	54	247

Source: MP&M pollutant loadings.

Table 12-15

Top Pollutants Removed by Option 2 for Non-Chromium Anodizing Indirect Dischargers[a]

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
NICKEL	3,218	29,251
MANGANESE	2,393	34,185
BORON	1,917	10,652
TOTAL SULFIDE	1,028	367
ZINC	966	20,552
FLUORIDE	350	9,999
ALUMINUM	267	4,165
COPPER	71	112
CADMIUM	44	17
TIN	39	129
IRON	22	3,868
ANTHRACENE	15	6
FLUORANTHENE	12	15
CHROMIUM	9	122
MAGNESIUM	6	6,833
FLUORENE	5	8
ACROLEIN	5	5

Source: MP&M pollutant loadings.
(a) EPA is not proposing pretreatment standards for all indirect discharging facilities in the Non-Chromium Anodizing subcategory. Therefore, the removals are presented only for informational purposes.

Table 12-16

Top Pollutants Removed by Proposed Option for Printed Wiring Board Indirect Dischargers

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
TIN	468,973	1,563,245
TOTAL SULFIDE	257,025	91,795
CYANIDE	253,216	230,197
COPPER	104,235	165,453
NICKEL	39,774	361,578
LEAD	23,781	10,810
BORON	14,805	82,250
MANGANESE	4,067	58,107
CHROMIUM	2,374	31,243
ZINC	2,090	44,460
IRON	1,732	309,307
FLUORIDE	1,568	44,797
CARBON DISULFIDE	1,510	539
ALUMINUM	1,164	18,187
AMMONIA AS NITROGEN	1,065	425,901
SILVER	740	46
MOLYBDENUM	701	3,507
COBALT	247	2,247
ANTHRACENE	245	98
FLUORANTHENE	200	250
ACROLEIN	112	116
FLUORENE	92	131
VANADIUM	69	111
CADMIUM	66	25
SELENIUM	63	57
TITANIUM	48	1,664
ANILINE	40	28
CHLORIDE	36	1,515,053
N-NITROSODIMETHYLAMINE	34	489
DI-N-OCTYL PHTHALATE	30	137
HEXAVALENT CHROMIUM	26	52
BIS(2-ETHYLHEXYL) PHTHALATE	24	252
2-METHYLNAPHTHALENE	23	286
MAGNESIUM	21	24,041

Source: MP&M pollutant loadings.

Table 12-17

Top Pollutants Removed by Proposed Option for Steel Forming and Finishing Indirect Dischargers

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
TIN	68,545	228,482
TOTAL SULFIDE	53,018	18,935
COPPER	37,074	58,848
BORON	4,355	24,193
FLUORIDE	3,093	88,365
IRON	1,425	254,463
NICKEL	1,229	11,174
ZINC	522	11,104
AMMONIA AS NITROGEN	359	143,769
VANADIUM	295	476
CHROMIUM	290	3,812
ANTHRACENE	270	108
LEAD	257	117
MANGANESE	250	3,565
FLUORANTHENE	221	276
CYANIDE	199	181
CHLORIDE	160	6,684,396
MOLYBDENUM	118	591
FLUORENE	101	145
ALUMINUM	72	1,122
TITANIUM	42	1,436
DI-N-OCTYL PHTHALATE	33	152
ANILINE	28	20
ACROLEIN	28	29
SELENIUM	26	24
SILVER	25	2
ARSENIC	22	6
COBALT	21	187
BIS(2-ETHYLHEXYL) PHTHALATE	19	202
2-METHYLNAPHTHALENE	17	216

Table 12-17 (Continued)

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
CADMIUM	16	6
MAGNESIUM	15	16,829
DIBENZOFURAN	14	69
3,6-DIMETHYLPHENANTHRENE	13	48
2,6-DINITROTOLUENE	11	111
N-NITROSODIMETHYLAMINE	11	158

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Source: MP&M pollutant loadings.

Table 12-18

Top Pollutants Removed by Proposed Option for Oily Wastes Indirect Dischargers[a]

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
TOTAL SULFIDE	40,158	14,342
MOLYBDENUM	35,485	177,425
BENZOIC ACID	366	1,108,465
LEAD	166	75
COPPER	137	217
ANTHRACENE	117	47
FLUORANTHENE	96	120
CADMIUM	93	36
SELENIUM	89	81
FLUORENE	44	63
ARSENIC	34	10
ZINC	33	710
NICKEL	26	236
IRON	25	4,411
BIS(2-ETHYLHEXYL) PHTHALATE	20	216
DI-N-OCTYL PHTHALATE	14	66
2-METHYLNAPHTHALENE	14	178
ANILINE	14	10
ACROLEIN	10	11
ALUMINUM	8	119
MAGNESIUM	7	7,949
3,6-DIMETHYLPHENANTHRENE	7	26
DIBENZOFURAN	7	33
CHROMIUM	6	82
N-NITROSODIMETHYLAMINE	6	86
2,6-DINITROTOLUENE	5	54
N-TETRADECANE	5	1,204
PYRENE	4	34
2-ISOPROPYLNAPHTHALENE	3	47
PHENANTHRENE	3	11
1-METHYLPHENANTHRENE	3	27
MANGANESE	2	30

Source: MP&M pollutant loadings.
(a) The Proposed Option for Oily Wastes indirect dischargers includes only those facilities that discharge greater than 2 MGY of process wastewater. The pollutant removals on this table reflect those associated with the Selected Option.

Table 12-19

Top Pollutants Removed by Option 10 for Railroad Line Maintenance Indirect Dischargers

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
LEAD	2.67	1.21
MANGANESE	2.13	30.4
ANTHRACENE	2.13	0.85
FLUORANTHENE	1.74	2.18
TIN	1.39	4.62
COPPER	1.00	1.59
BORON	0.801	4.45
FLUORENE	0.798	1.14
FLUORIDE	0.527	15.1
CADMIUM	0.427	0.164
SILVER	0.299	0.019
SELENIUM	0.274	0.249
DI-N-OCTYL PHTHALATE	0.221	1.00
ALUMINUM	0.216	3.38
MERCURY	0.214	0.002
ANILINE	0.208	0.149
ZINC	0.192	4.09
MOLYBDENUM	0.190	0.950
VANADIUM	0.184	0.296
2-METHYLNAPHTHALENE	0.147	1.84
CARBON DISULFIDE	0.140	0.050
NICKEL	0.124	1.13
IRON	0.120	21.4
BIS(2-ETHYLHEXYL) PHTHALATE	0.115	1.21
ARSENIC	0.114	0.032
HEXAVALENT CHROMIUM	0.106	0.208
DIBENZOFURAN	0.102	0.512
3,6-DIMETHYLPHENANTHRENE	0.094	0.346
COBALT	0.086	0.780
2,6-DINITROTOLUENE	0.085	0.850
N-NITROSODIMETHYLAMINE	0.073	1.05
PYRENE	0.067	0.609
ACROLEIN	0.066	0.068
PHENANTHRENE	0.056	0.193

Source: MP&M pollutant loadings.

Table 12-20

Top Pollutants Removed by Option 10 for Shipbuilding Dry Dock Indirect Dischargers

Pollutant Name	Toxic Pound Equivalents Removed (lb-eq/yr)	Pounds Removed (lb/yr)
BORON	26.1	145
MOLYBDENUM	0.062	0.309
MANGANESE	0.030	0.426

Source: MP&M pollutant loadings.